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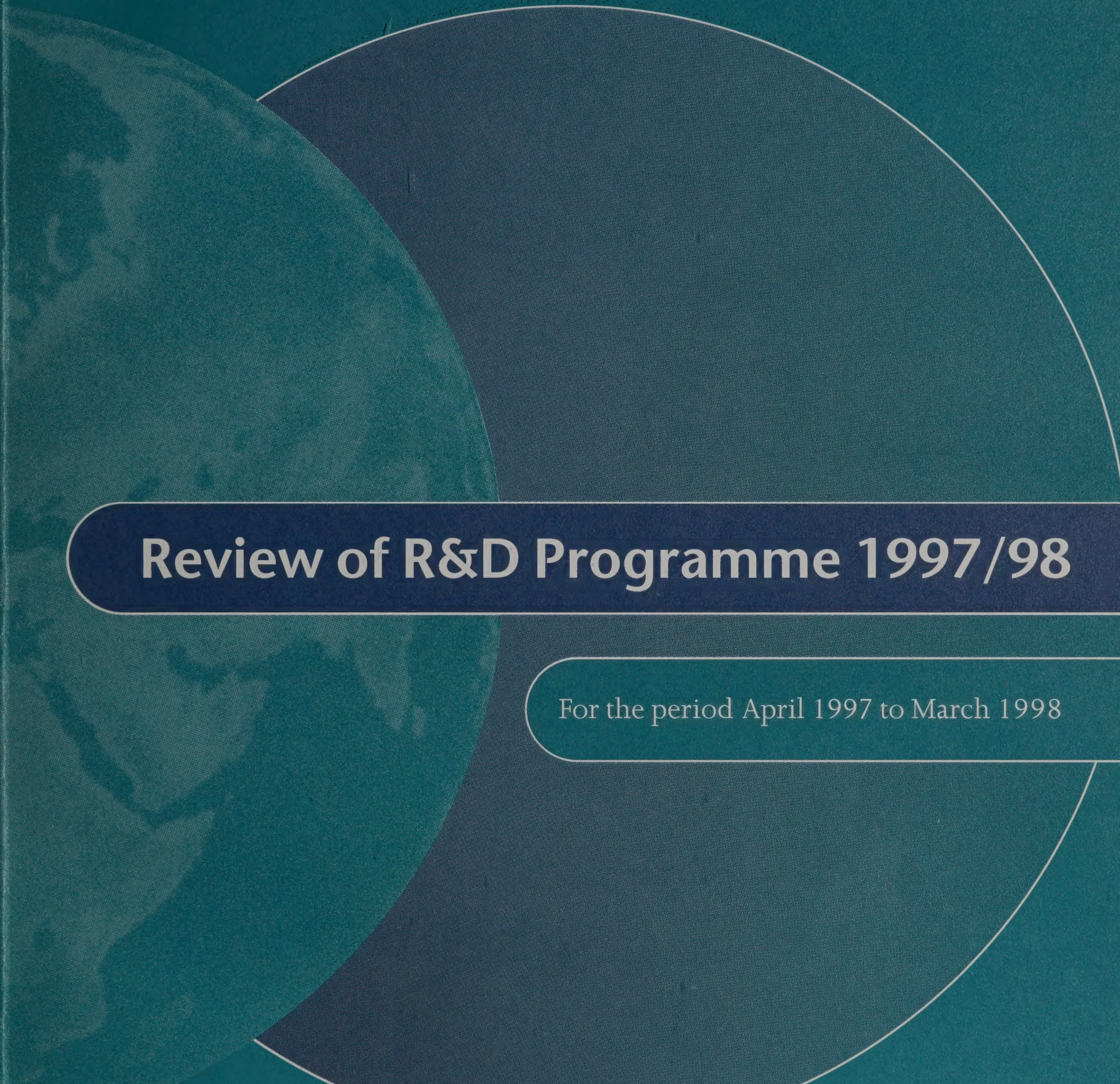

Review of R&D Programme 1997/98

For the period April 1997 to March 1998

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Review of R&D Programme 1997/98

For the period April 1997 to March 1998

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Glossary of Abbreviations

AMP	Asset management plan
BAP	Biodiversity action plan
BATNEEC	Best available techniques not entailing extra cost
BBSRC	Biotechnology and Biological Sciences Research Council
BPEO	Best practicable environmental option
BSRIA	Building Services Research and Information Association
CARACAS	EC Concerted Action on Risk Assessment for Contaminated Land
CCMS	Centre for Coastal and Marine Sciences
CCW	Countryside Council for Wales
CIRIA	Construction Industry Research and Information Association
DETR	Department of the Environment, Transport and the Regions[1]
DGXI	Directorate General XI
Dti	Department of Trade and Industry
EC	European Commission
EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
EU	European Union
HSE	Health and Safety Executive
IPC	Integrated pollution control
IPCC	Inter-governmental Panel on Climate Control
JNCC	Joint Nature Conservation Committee
LEAP	Local Environment Agency plan
MAFF	Ministry of Agriculture, Fisheries and Food
NAQ	National air quality
NERC	Natural Environment Research Council
NETCEN	National Environmental Technology Centre
OPRA	Operator and pollution risk appraisal
R&D	Research and development
RSA93	Radioactive Substances Act 1993
RSPB	Royal Society for the Protection of Birds
RTD	Research and technological development
SEPA	Scottish Environmental Protection Agency
SET	Science, engineering and technology
SNIFFER	Scottish and Northern Ireland Forum for Environmental Research
STW	Sewage treatment works
UKWIR	United Kingdom Water Industry Research
URGENT	Urban Regeneration and the Environment
WCA	Water Company Association
WRc	Water Research Centre
WSA	Water Services Association

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[1] Replaced Department of the Environment (DoE), May 1997

Foreword

Under the Environment Act of 1995, the Environment Agency has a responsibility to "make arrangements" for the carrying out of research and related activities in support of its responsibilities, and to make the results of this work available to others.

This Annual R&D Review reports on projects completed in the Agency's second operational year - from April 1997 to March 1998. Most of the results have already been used in support of the Agency's business, at the strategic, policy, development or operational level. I commend this Review as a record of what was produced, and as an aid to considering whether the various outputs are of interest to you or relevant to your needs.

Section 1.5 of the Review tells you what to do if you want to obtain a copy of any R&D output or a Technical Summary. These can be obtained from the new Environment Agency Dissemination Centre.

The Agency's R&D Programme does not stand still. Following its *Environmental Strategy for the Millennium and Beyond* (1997), the Agency has now published its *R&D Strategy* (1998), which sets out a new thematic structure to its R&D programme. In order to assist in the transition to a thematic programme, the work in this review is reported against both the traditional approach, and in a new thematic structure.

R. J. Pentreath

Dr R. J. Pentreath
Chief Scientist and Director of Environmental Strategy

1. Introduction

Welcome to this review of the outputs from the Environment Agency's Research and Development (R&D) Programme for 1997/98.

The Agency is the most comprehensive environmental protection body in Europe. It has more than 9,000 staff and an annual turnover in excess of £550 million. It is primarily concerned with pollution prevention and control and the management of water in the environment, including flood defence. It also has duties to make a contribution towards sustainable development, to form an opinion on the state of pollution of the environment, and to take an integrated approach to environmental management.

In developing this more integrated and long-term view of environmental management at a national level, the Agency published its *Environmental Strategy for the Millennium and Beyond* in September 1997. This outlines a structure of Frameworks for understanding the state of the environment and the pressures acting upon it, and nine key Environmental Themes designed to help the Agency achieve its environmental objectives. These are discussed in detail in Chapter 3. To deliver this strategy and to achieve its goals, the Agency is investing in the science, engineering and technology (SET) relevant to all its activities. It does this by:

- financing and running an R&D programme (largely external) which fully supports its functional activities on a strategic, policy development and operational level;
- interfacing its R&D programme with those of others in order to focus and maximise the values obtained;
- maintaining and developing its own national centres of excellence to provide scientific and technical expertise, support and advice to its staff and others, including provision of tools and methodologies, and guidance for environmental monitoring and assessment techniques.

The Agency published its overall strategy for running its R&D programme in its *R&D Strategy* in October 1998. This is supported by *Current R&D*, an annual insert summarising the structures and objectives of the Agency's R&D programme for the current year (starting in May 1998 for 1998/99).

1.1 Purpose of the Review

The Environment Act 1995 places a duty on the Agency to carry out R&D. It states that the Agency:

> "(a) must make arrangements for carrying out of research and related activities in respect of matters to which its functions relate; and
>
> (b) may make the results of any research or related activities available to any person".

Furthermore, the Agency's management statement set by Government requires it to operate to "high professional standards, based on sound science".

The Agency operates in an open manner with regard to the EC Directive on Freedom of Access to Environmental Information (90/313/EEC). It therefore publishes as much information as is practicable about the results of its R&D programme.

This review contains details of all R&D outputs produced by the Agency in 1997/98 under the Agency's R&D programme. Some of the projects completed during this period were inherited from the Agency's predecessors.

The review provides a source of reference to staff within the Agency and to external organisations and individuals having interests in similar areas of SET. It facilitates communication and the exchange of research information between the Agency and the organisations with which it collaborates, as well as the dissemination of information to those working in the SET base. This sharing of new knowledge and understanding is considered key to the development of new and more effective tools and techniques for managing the environment.

1.2 Content of the Review

Following this chapter explaining the Agency's approach to R&D, Chapter 2 outlines the 13 R&D commissioned programmes under which all the outputs for 1997/98 were produced, and explains their current rationale and key R&D objectives. Although these outputs were the products of the commissioned programmes, they are reported under the frameworks and key environmental themes (Chapter 3) that underpin the Agency's environmental and R&D strategies. The appendices offer further information, including a list of all staff involved in the R&D programme, together with their location (Appendix 1); a list of all the outputs by commissioned programme, with a cross-reference to the frameworks and themes (Appendix 2); a list of all projects ongoing at the end of 1997/98 (Appendix 3); and a bibliography (Appendix 4).

1.3 Structure of R&D Programmes

Up to the end of 1997/98, the Agency structured its R&D on a co-ordinated system of commissioned programmes, each supporting an Agency function. Where projects addressed several function areas, they were placed in the most relevant commissioned programme, but part-funded from others as appropriate (see Figure 1.1: Expenditure on R&D by Commissioned Programme).

As mentioned above, future R&D will be driven by frameworks and key environmental themes. The Agency's *R&D Strategy* (published October 1998) explains how this will be accomplished. In effect the Agency will manage a portfolio of best environmental R&D options based on a thematic approach in order to develop an integrated means of delivering a better environment.

The evolutionary approach required to shift the focus from the current commissioned programmes to R&D programmes centred on the Agency's *Environmental Strategy* is taking place over a two-year transitional period - 1998/99 and 1999/2000. It is expected that the new approach will be fully implemented in the 2000/01 financial year.

The breakdown of the Agency's 1997/98 R&D programme by Frascati definition – that is, the nature (basic or applied) of R&D addressed by a project – is shown in Figure 1.2. A further analysis of the R&D programme by the Agency's primary purpose is illustrated in Figure 1.3 using the following categories:

- strategic
- policy development
- operational efficiency.

Figure 1.1

Expenditure on R&D by Commissioned Programmes

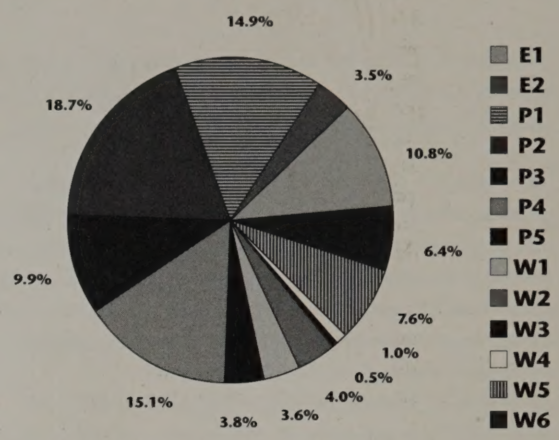


Figure 1.2

Breakdown of R&D in 1997/98 by Frascati Definition

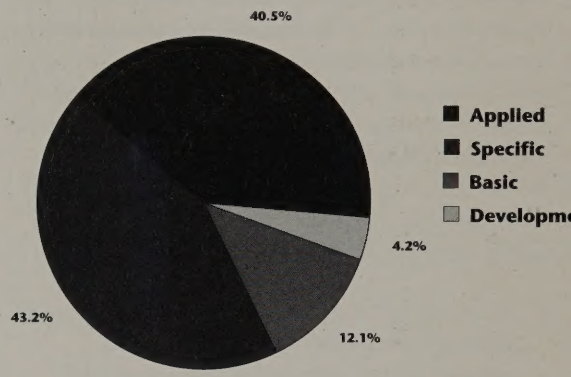
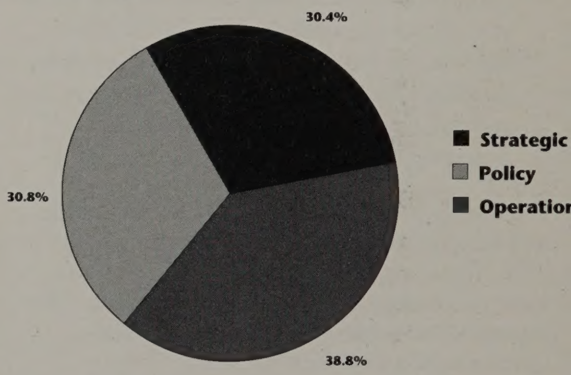


Figure 1.3

Breakdown of R&D Programme in 1997/98 by Primary Purpose



1.4 R&D Management

Each commissioned programme (see Chapter 2) has been managed by a senior officer from the Agency function concerned, termed a programme officer. Each programme has generally been subdivided into a number of topic areas addressing particular aspects of the function's business and co-ordinated by topic leaders with expertise in that area. Each R&D project is overseen by a project manager from the function, or a National Centre, with appropriate operational or business experience.

The overall programme is planned, co-ordinated and supported through the R&D section, which comprises a small R&D unit in the Bristol head office, plus R&D management support officers located in each region and in the London and Bristol offices. External expert advisers are also employed to ensure that the Agency is aware of best scientific knowledge and is not duplicating work done elsewhere, and to confirm that the proposed approach is the most appropriate to the issue in question.

The Agency is not in the business of carrying out all of the research itself. The bulk of the work is contracted out to the best available R&D contractors, taking into account both cost and quality. The R&D projects are managed by mainstream Agency staff, as project managers, who understand the context of the R&D and ensure that the results are suitable for the intended purpose. They also benefit from exposure to new knowledge and links to the external R&D community. The Agency recognises that R&D management requires special expertise and provides a support service to all the mainstream staff to assist in the planning and management of R&D projects and programmes.

The R&D projects in each commissioned programme are developed and approved by the relevant functional management group. The progress of the Agency's R&D programme depends on the effort of its staff in managing the projects, topics and commissioned programmes. Appendix 1 lists all staff involved in the R&D programme, together with their location.

This management structure is more fully described in *A Short Guide - Research and Development in the Environment Agency*, available from the R&D unit or R&D service offices.

1.5 R&D Outputs

The overall success of an R&D project depends upon the products of that research being delivered to the end-user in a manner that allows the information or equipment to be used. To facilitate this, every Agency output has a designated implementation plan for its uptake and use. Information on the background, results and exploitation of the project is provided in the R&D technical summary associated with each output. A statement of use is also given on the inside page of each output.

Outputs for 1997/98 are listed by commissioned programme (with cross-references to frameworks and themes) in Appendix 2 of this review, along with their availability and where they can be obtained. Most outputs are available from the Agency bookshop at the Water Research Centre (WRc):

The Bookshop Manager
Environment Agency Dissemination Centre
WRc plc
Franklin Road
Blagrove
Swindon
Wiltshire SN5 8YF
Tel 01793 511711
Fax 01793 514562
e-mail: publications@wrcplc.co.uk
Website: www.wrcplc.co.uk/rdbookshop

All R&D outputs are available for inspection by the public and Agency staff at our Information Centre in Bristol and through regional information centres (where they exist), or through the Customer Services Department at the British Library (tel 01937 546060).

To ensure that all interested parties are aware of the R&D outputs produced by its predecessors, the Agency has published *The Agency's Research Inheritance - A List of Outputs and Guide to Their Availability*. This can be obtained from WRc.

1.6 R&D Programmes for 1998/99 and 1999/2000

The Agency's *R&D Programme 1998/99 - Schedule of Proposed New Starts* has been published (May 1998) as a separate document. This lists all proposed projects due to start in the 1998/99 financial year. The Agency has also published the *R&D Programme 1998/99 - Schedule of Ongoing Projects and Proposed New Starts* which lists the projects by frameworks and themes. For availability of these two documents, contact the R&D service at the Agency's Westbury-on-Trym office. As previously, the Agency continues to carry out R&D for a range of purposes in support of its own business, covering strategic, policy-related and operational activities.

The Agency's R&D programme for 1999/2000 is planned for publication in April or May 1999, and will be available from the R&D service, as above.

1.7 Partnerships in Science and Technology

In managing various aspects of the environment, the Agency works in partnership with other stakeholders with which it shares an interest. This is reflected in the Agency's R&D programme, where good co-operation and the development of partnerships with other bodies are recognised as important in terms of value for money, commonly owned results and use of research resources.

Collaboration – in terms of joint or parallel funding of research projects – took place with a range of other R&D organisations in the 1997/98 R&D programme, in particular with:

- European partners, including corresponding environmental authorities in other member states;
- Department of the Environment, Transport and Regions (DETR), Ministry of Agriculture, Fisheries and Food (MAFF) and the Welsh Office, who have parallel R&D programmes to develop policy, advise ministers and address international obligations;
- Scottish and Northern Ireland Environment Agencies, through SNIFFER (Scottish and Northern Ireland Forum for Environmental Research), addressing common R&D interests and the ability to carry out some R&D on a national (UK) basis;
- Research councils, whose support for research institutes and academic organisations underpins the nation's SET base. These include Natural Environment Research Council (NERC), Engineering and Physical Sciences Research Council (EPSRC), Biotechnology and Biological Sciences Research Council (BBSRC) and Economic and Social Sciences Research Council (ESRC);
- Industry goups which share a common interest, including the chemical, water, waste and environmental industries, and bodies such as the CBI and Business in the Environment.

The European partners address issues and develop common approaches relevant to all European member states. In adopting a pro-active stance towards European issues, the Agency has also provided advice to the EC on priorities for the EU's fourth and fifth framework research and technological development (RTD) programme.

In the planning and management of the Agency's R&D, topic leaders and project managers have liaised with and visited relevant experts and organisations in Europe and North America to ensure that projects funded by the Agency take account of both existing best practice and research currently under way, and do not duplicate effort.

The Agency has also played an important part in the Government's Foresight initiative for co-operation between the public and private sectors, particularly on the Natural Resources and Environmental Panel, to ensure that research in the UK develops new strategic leads involving both wealth creation and quality of life.

1.8 Technical Services

The Agency has a number of technical services that its staff can draw upon to help translate the outputs of research, draw together other practitioner information and answer specific queries. These include:

- environmental quality sampling and statistics;
- environmental toxicology;
- waste water treatment processes;
- analytical quality control and laboratory method development;
- specialist enquiry service;
- specialist enquiry service, water resources;
- urban pollution management;
- freshwater biology;
- status and distribution of flora and fauna of the UK;
- control of aquatic and bankside weeds;
- toxicity of algal scums;
- waste management, contaminated land and pollution abatement.

They are funded by the commissioned programme requesting the information.

1.9 Fellowships and Studentships

In addition to R&D projects commissioned to inform policy-makers or to provide operational guidance, tools and techniques, the Agency sponsors a small number of studentships for graduates working towards a PhD, and fellowships for those pursuing post-doctoral work.

These pieces of research are currently aligned to the commissioned programme that provides the funding, but are less specific as to the expected outcomes. They are run in conjunction with some of the research councils and provide a valuable link between the research community and the Agency, which is the end-user of many of the results. These have proved to be very effective, when working with an experienced supervisor, in providing new, underpinning knowledge on which the Agency can base new policies and guidance.

2. R&D Commissioned Programmes

2.1 Introduction

The R&D programme is currently structured in 13 commissioned programmes supporting the Agency's core function areas of:

E1	Environmental monitoring and assessment
E2	Sustainable development
P1	Waste regulation and management
P2	Water quality (formerly water pollution control)
P3	Radioactive substances
P4	Process industries regulation (formerly integrated pollution control)
P5	Land quality (formerly contaminated land)
W1	Conservation
W2	Fisheries
W3	Recreation and navigation
W4	Local government liaison
W5	Flood defence
W6	Water resources.

The outputs produced by these commissioned programmes are reported in Chapter 3 under frameworks and key environmental themes. The business rationale, key R&D objectives and budgets for each programme are detailed below.

Table 2.1
1997/98 R&D Budgets by Commissioned Programmes

Commissioned Programme	Budget (£k)
Environmental monitoring and assessment	1,131
Sustainable development	368
Waste regulation and management	1,558
Water quality	1,952
Radioactive substances	1,037
Process industries regulation	1,572
Land quality	397
Conservation	375
Fisheries	413
Recreation and navigation	52
Local government liaison	108
Flood defence	794
Water resources	671
Total	**11,208**

2.2 Environmental Monitoring and Assessment

2.2.1 Business Rationale

The function's mission is to provide a consistent, effective and integrated national framework for monitoring and assessing the state of the environment in relation to the pressures placed upon it, in order to support the Agency's environmental management role and to provide meaningful information on the environment for all those interested in it.

The research programme's business rationale is to underpin the function's mission with sound science, innovative methods for assessing the environment, new technology and holistic approaches for monitoring and assessing air, land and water. Environmental monitoring and assessment are key elements in the Agency's management plan for carrying out its new duties to assess the state of the environment, contributing towards sustainable development and maintaining biodiversity.

Monitoring and assessment are currently carried out by the Agency functions and by external organisations such as NERC institutes and MAFF. The Agency will need to promote better co-ordination of these activities through co-operative research programmes with external agencies and other research programmes in the UK and Europe, including NERC, DETR, MAFF, SEPA, JNCC, the European Environment Agency and its topic centres and universities.

2.2.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Environmental Monitoring and Assessment are:

- to describe the "stock" of environment effectively – physically, chemically and biologically;
- to assess compliance with environmental standards more efficiently;
- to determine the "health" of biota and their long-term changes;
- to improve the way in which we determine the aesthetic quality of the environment.

2.3 Sustainable Development

2.3.1 Business Rationale

The Sustainable Development function exists to promote the adoption of practices and values that support the achievement of sustainable development, in both the exercise of the Agency's own activities and the influence it brings to bear on others.

The principles of sustainable development require the Agency to have greater regard than has previously been the case for the economic and social aspects of its activities. This part of the business also focuses on a longer term perspective that has regard for the needs of future generations, both anticipating and evaluating risk.

The widespread interest in sustainable development, and the pervasive nature of many of the associated concepts and methodologies, means that there is considerable opportunity for collaboration. This is taking place with: the Countryside Commission, English Nature and English Heritage on the environmental capital project; SEPA on the further development of sustainability indicators and economic instruments; WRc, DETR, WCA/WSA and DGXI on a pan-European sustainable water management project; and ETSU on green accounting and externalities of energy projects. Discussions are taking place with the Global Atmosphere Division concerning the Agency's involvement in its core programme research into climate change.

In addition, there are a significant number of projects in other Agency programmes that could yield greater benefits if they were to adopt a broader "whole Agency" outlook, and this will be pursued as the projects are developed.

2.3.2 Key R&D Objectives

The initial phases of the R&D programme, which include the new starts for 1997/98, have been designed to provide a suite of new tools applicable throughout the Agency's activities.

The programme objectives that flow from the Agency's strategic objectives for Sustainable Development are:

- to develop economics as an area in which our new statutory duty to have regard to costs and benefits makes this a business-wide opportunity;
- to concentrate on providing a framework for risk analysis and an understanding of the current basis of environmental standard setting in the UK;
- to enhance understanding of sustainable development issues, move toward techniques that allow quantification of progress, and consider the wider application of existing practices across other Agency functions (for example, resource demand management). In addition, there will be further work on the impact of climate change on the Agency's activities.

2.4 Waste Regulation and Management

2.4.1 Business Rationale

The national waste strategy, *Making Waste Work*, sets a framework within which future government policy will be formulated. It is based on the concept of sustainable development, in which the waste management needs of the present generation should be met without compromising the ability of future generations to meet their own needs.

Technical advice to the DETR on the implementation of the national strategy is provided under a memorandum of understanding between the Agency and the department. The implementation of the national strategy will require the support of a research programme designed to inform policy initiatives, to set standards and targets, and to put into place systems to monitor progress towards their achievement and effectiveness.

The Waste Regulation and Management function provides a harmonised national approach to waste regulation and improves waste management standards by providing relevant and up-to-date guidance notes and papers on various techniques. Some of the guidance defines standards; that on the licensing of waste management facilities is statutory.

2.4.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Waste Regulation and Management are:

- to provide information on the acceptability and sustainability of current waste management practices and the effectiveness of current control measures;
- to underpin technical guidance that moves landfilling practices towards sustainable development goals and ensures that landfilling is a safe waste disposal option;
- to produce information on controlled wastes, their management, costs and environmental impacts, and to provide a means of assessing the best practicable environmental option (BPEO) for their disposal/recovery.

2.5 Water Quality

2.5.1 Business Rationale

The overall business aim is to achieve a continuing and overall improvement in the quality of rivers, groundwaters, lakes and canals, estuaries and coastal waters through the prevention and control of pollution. To support this aim, the Agency needs effective R&D to underpin development of policy, improvements in efficiency, advances in regulatory control and firm scientific understanding of the water environment and the impacts upon it. Major issues requiring attention within the R&D programme include toxicity-based assessment, dangerous substances and urban drainage.

The Water Quality programme for 1997/98 includes a large element of collaborative R&D. One major example is Agency funding of a number of projects within the NERC environmental diagnostics programme, a thematic programme costing more than £6 million, addressing R&D required to underpin key elements of pollution prevention and control. CIRIA collaborative projects and joint undertakings with partner organisations such as SNIFFER also feature strongly.

2.5.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Water Quality are:

- to provide underpinning information for the derivation of environmental quality standards, and to assist in the formulation and implementation of statutory water quality objectives and the General Quality Assessment Scheme;
- to provide methodologies and techniques for assessing the impact of discharges to controlled waters and to develop new methods for controlling pollution arising from such sources;
- to provide information and introduce best practice for assessing and controlling diffuse pollution from agricultural activities and forestry practices;
- to provide methods for, wherever possible, preventing pollution and assessing the extent of, and subsequently controlling, the pollution of groundwaters;
- to develop and introduce new techniques for preventing and controlling pollution from road run-off, firewater and other accidental and deliberate unauthorised spillages.

2.6 Radioactive Substances

2.6.1 Business Rationale

The Radioactive Substances R&D programme will maintain a primary focus on the regulatory aspects of the geological disposal of solid intermediate-level and low-level radioactive wastes. This area is of key importance because government policy continues to favour disposal rather than indefinite storage of these wastes. The Agency must continue to prepare itself for the major, technically complex, task of determining any application under the Radioactive Substances Act 1993 (RSA93) for an authorisation to dispose of them to a future repository. The Agency also needs to maintain its expertise to assess safety cases, submitted under RSA93, for existing radioactive waste disposal facilities.

The programme is being broadened into two further areas, namely regulatory activities other than geological disposal, and environmental (non-human species) research. These areas reflect changes in disposal practices, the need for the Agency to maintain and develop its assessment capability now that it is the sole regulator under RSA93 in England and Wales, and the broader duties of the Agency under the Environment Act 1995.

The programme is built on extensive collaboration with government departments and industry in the UK and the EC, and with partner organisations in France, Germany, Belgium, Italy, the Netherlands, Spain, Portugal, Greece, Sweden, Finland, Canada, Japan and South Africa. The Agency thus exerts a substantial influence, through a well-targeted programme, on the direction of relevant R&D at an international level.

2.6.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Radioactive Substances are:

- to provide a clear understanding of the issues involved in the assessment of the long-term safety of radioactive waste disposal;
- to provide underpinning information and guidance to support the independent assessment of proposals and applications for the disposal of radioactive waste;
- to provide information on the options for and risks associated with the disposal of radioactive waste, in support of the Agency's position in any future public inquiry;
- to ensure that the Agency discharges its broader statutory duty for environmental protection in respect of radioactive substances regulation.

2.7 Process Industries Regulation

2.7.1 Business Rationale

The overall business aim is to ensure that the Agency, in its regulation of Integrated Pollution Control (IPC) processes, draws on the best available science to minimise adverse effects on the environment, while taking full account of the associated costs and benefits. An integral part of this approach is the development of tools for use by IPC inspectors and the provision of the necessary input data.

The scientific approaches to environmental protection are common to a number of commissioned programmes and close links will be developed. Similarly, existing close links with the research programme of the DETR and research council initiatives will continue. In particular the programme will take account of the NERC environmental diagnostics and URGENT programmes. Collaboration will continue with the National Centre for Environmental Toxicology, the National Environmental Technology Centre (NETCEN), NERC institutes and universities.

2.7.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Process Industries Regulation are:

- to develop techniques for assessing the pathways and impacts of pollutants in the environment, including interpretation of data on ambient levels of pollution in air, soil and water;

- to provide new methods for assessing the impact of complex industrial processes on the environment, including new statistical tools for evaluating diverse sources of data;

- to determine the effect that new industrial practices may have on the environment, and to identify and promote the development of new technologies for the quantification of pollutant releases;

- to establish a methodology and procedure for identifying and justifying the best practicable environmental option, including the integration of economic considerations.

2.8 Land Quality

2.8.1 Business Rationale

The main business driver for the function is to ensure that procedures are in place for the effective delivery of the Agency's regulatory duties prior to the implementation of the new contaminated land regime. To support these duties, a key issue is the need to establish a sound information strategy to ensure efficient data management.

The principal aim of the research programme is to support the Agency's aims and objectives in contaminated land, namely to: secure, with others, the remediation of contaminated land; regulate special sites efficiently and effectively; and report on the state of contaminated land in the UK.

Where appropriate, the Agency will work with other organisations to achieve the programme objectives. Potential collaborators for 1997/98 include development agencies, research councils and industry. The research programme also takes account of work in other countries and of possibilities for the UK to contribute to important international developments in this area through involvement in, for example, the NATO Centre for Coastal and Marine Sciences (CCMS) study and the EC Concerted Action on Risk Assessment for Contaminated Land (CARACAS).

2.8.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Land Quality are:

- to promote the appropriate remediation of contaminated land, with particular emphasis on issues of sustainability and a consideration of costs and benefits;

- to develop procedures for the effective delivery of the regulatory and advisory functions of the Agency in land contamination, in order to assist us in performing our duties under Section 57 of the Environment Act;

- to develop current scientific knowledge on risk assessment and risk management, and to encourage best practice through the provision of high-quality technical advice on land contamination, in order to promulgate a transparent, consistent and technically robust approach to contaminated land management;

- to identify information needs to support the development of a strategy to ensure efficient information exchange, dissemination and analysis, and to assist in the preparation of the report on the state of contaminated land in the UK.

2.9 Conservation

2.9.1 Business Rationale

The overall business aim is to ensure that the Agency, in all that it does, helps sustain and, wherever possible, improve the natural and man-made heritage in England and Wales. In delivering its key business objectives, the Conservation function is supported by a business-focused R&D programme which underpins the development of policy, enables improvements in efficiency and effectiveness, and provides a firm scientific and technical base. This extends to the identification and subsequent introduction of best practice. The main drivers for the function are the need to fulfil the Agency's obligation as a competent authority under the EU Habitats Directive, and its responsibilities for helping to implement the UK Biodiversity Action Plan.

Given that conservation applies across all the Agency's activities, there is close collaboration with all the other commissioned programmes. Similarly, given the number of close links with external partner organisations, a large proportion of conservation projects involve collaboration with bodies such as English Nature, CCW, Forestry Authority, RSPB, SEPA, JNCC, DETR and universities.

2.9.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Conservation are:

- to develop effective survey, monitoring and classification methods for assessing conservation interest;
- to evaluate environmental impacts and identify criteria for maintaining and enhancing conservation interest;
- to develop cost-effective management strategies and techniques that are consistent with the Agency's responsibilities for conservation and biodiversity.

2.10 Fisheries

2.10.1 Business Rationale

The overall business aim is to maintain, improve and develop fisheries in order to provide the nation with high-quality, diverse, sustainable fisheries and to enable their cost-effective management. Business priorities driving the R&D programme include:

- the need for effective, scientifically sound methods to classify and assess fisheries resources;
- the need for improved understanding of customer needs and fisheries economics to ensure fair financial strategies and better communications;
- the requirement to take costs and benefits into account in decision making;
- formulation of rational policies and development of species-specific, sustainable management strategies based on sound, high-quality science (a salmon strategy has been prepared; those for coarse fish, eels and trout will follow);
- better management of land use to protect fisheries habitat;
- authorisation of fish passes and associated design criteria;
- application of cost-effective methods for restoration and maintenance of fisheries.

2.10.2 Key R&D Objectives

There are three themes in the changing direction of Fisheries R&D: more formal use of modelling to aid decision- and target-based management; a shift from purely biological to economic and social measures of fishery performance; and a greater emphasis on coarse fishery studies to redress an imbalance.

The programme objectives that flow from the Agency's strategic objectives for Fisheries are:

- to describe resource characteristics and develop integrated classification systems, inventories and systems for survey, monitoring and reporting of the national fishery resource status;
- to develop understanding of the processes controlling performance of stocks and fisheries (including biological, social and economic variables), leading to definition of performance measures and to models that can be used to guide and evaluate management decisions and predict the influence of environmental factors and fishing levels;
- to develop innovative and effective methods, equipment and procedures to assist the Agency to practically manage stocks, fisheries and habitat in a justifiable, sustainable and cost-effective way.

2.11 Recreation and Navigation

2.11.1 Business Rationale

The Recreation function requires appropriate and detailed supply-and-demand data to feed into the broad planning and operational processes. More specifically this means Local Environment Agency Plans (LEAPs), county and local structure plans, site management plans for Agency-owned sites, and promotion plans for watersport activities.

A key aim, essential to the success of the Navigation Strategy, is our ability to manage our navigation as an integral part of the environment and to demonstrate best practice.

The Sports Council, Countryside Commission and various governing bodies for sport and recreation are collaborating on this project, in terms of either financial assistance or sharing of databases, experience and knowledge.

Where appropriate, we will collaborate with governing bodies for sport, such as the British Canoe Union, and other navigation authorities, such as British Waterways. We will also seek to collaborate with the Agency's Flood Defence function.

2.11.2 Key R&D Objectives

To date, no one organisation provides strategic supply-and-demand data to the level required by the recreation function, nor is the data updated regularly. A key R&D objective is therefore to develop a cost-effective means of gathering and managing supply-and-demand data. In the short term, several specific studies will be carried out to provide urgently needed data to enable the function to fulfil current business needs.

The programme objective that flows from the Agency's strategic objectives for Recreation and Navigation is:

- to provide new methodologies, techniques and support information to assist the Agency in its recreation and navigation duties.

2.12 Local Government Liaison

2.12.1 Business Rationale

In delivering its objectives, the Local Government Liaison function is aided by an R&D programme that supports its development, progresses efficiency and effectiveness, and provides a technical base for its day-to-day activities. This includes the identification, introduction and consequent monitoring of best practice. The main issues driving the function are the general need to improve our effective liaison with local authorities, the promotion of a more proactive approach to our land-use planning work, and the successful production of effective LEAPs.

Where beneficial to achieving the programme objectives for Local Government Liaison, opportunities will be sought to undertake specific R&D in collaboration with the programmes of other relevant organisations. In particular, increased recognition and input to the research of the Royal Town Planning Institute are expected.

2.12.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Local Government Liaison are:

- to develop and improve the relationship and effective links between LEAP action plans and business planning, to ensure that methods are consistent and to increase the effectiveness of LEAPs;
- to improve the understanding and implementation of the pro-active approach being promoted for input to the planning system in order to ensure a consistent and optimum input, especially at the strategic level of the land-use planning system;
- to improve the relationship between our input to the planning system and our authorisation procedures, thereby increasing our effective influence over the land-use planning system.

2.13 Flood Defence

2.13.1 Business Rationale

In delivering its key objectives, the Flood Defence function is supported by a business- focused R&D programme that supports the development of policy, enables improvements in efficiency and effectiveness, and provides a firm scientific and technical base. This extends to the identification and subsequent introduction of best practice. In order to meet planned targets, the main R&D issues for the function are the need for a more strategic approach to the management of rivers, estuaries and the open coast, and for improved effectiveness of the flood warning system.

Close liaison with MAFF is an important element in the development of Flood Defence R&D, the principle being that the Agency will, where appropriate, take on the outputs from strategic (MAFF-led) research, and develop and implement practical outputs. Where beneficial, collaborative projects will be undertaken and projects planned with NERC, EPSRC, DETR, the Met Office, Highways Agency, CIRIA and universities.

2.13.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Flood Defence are:

- to improve understanding of natural processes and their influence on the environment, to enable better decision making and improved value for money;
- to provide new methodologies, techniques and supporting information to assist in flood defence management;

- to provide new methods of improving the operational management of rivers, and new techniques for designing and managing tidal defences;

- to develop new and improved approaches to the forecasting of floods, and to improve the Agency's ability to respond to emergencies involving flooding.

2.14 Water Resources

2.14.1 Business Rationale

In delivering its key business objectives, the Water Resources function is supported by a focused R&D programme that supports the development of policy, enables improvements in efficiency and effectiveness, and provides a firm scientific and technical base for the day-to-day operation of the function. This extends to the identification and subsequent introduction of best practice. The main business drivers for the function are the need to have an effective input to the next periodic review (AMP 3) and to update the Agency's water resources development strategy.

Where beneficial to achieving the programme objectives for Water Resources, opportunities are sought to undertake specific R&D in collaboration with the programmes of other relevant organisations. As in previous years, the 1997/98 programme features a number of collaborations with the UK Water Industry Research Ltd (UKWIR), NERC, SNIFFER, BSRIA, the DTI, universities and individual water companies.

2.14.2 Key R&D Objectives

The programme objectives that flow from the Agency's strategic objectives for Water Resources are:

- to develop and improve hydrometric instrumentation and related techniques to ensure that methods are consistent, cost-effective and reliable;

- to improve the understanding of the inter-relationship of river flow and environmental factors to achieve a balance between water consumption and environmental protection;

- to develop and improve water resources assessment and management techniques to secure optimum strategies and policies for the use of water resources;

- to understand groundwater recharge mechanisms and aquifer properties in order to improve the integration of groundwater quality and quantity issues;

- to develop understanding of the effectiveness, cost and applicability of measures to manage the demand for water in households, industry, commerce and agriculture.

3. Frameworks and Key Environmental Themes

3.1 Introduction

The Agency has set out in its *Environmental Strategy for the Millennium and Beyond* how it intends to take forward an integrated approach to the management of the environment. In doing this, the Agency intends to make a significant contribution towards the achievement of sustainable development. Its approach concentrates on those areas of environmental management for which it has direct or shared responsibility.

To identify the best areas in which to take action, the Agency's *Environmental Strategy* has established four frameworks (Figure 3.1) – the first for assessing the *state* of the environment at any one time; the second for considering the *pressures* that are affecting it, and the third for looking at *options* for taking action. The fourth enables it to deliver the right *responses* through environmental management action to achieve a better environment.

Nine key environmental themes have been identified on which the Agency will focus its responses:

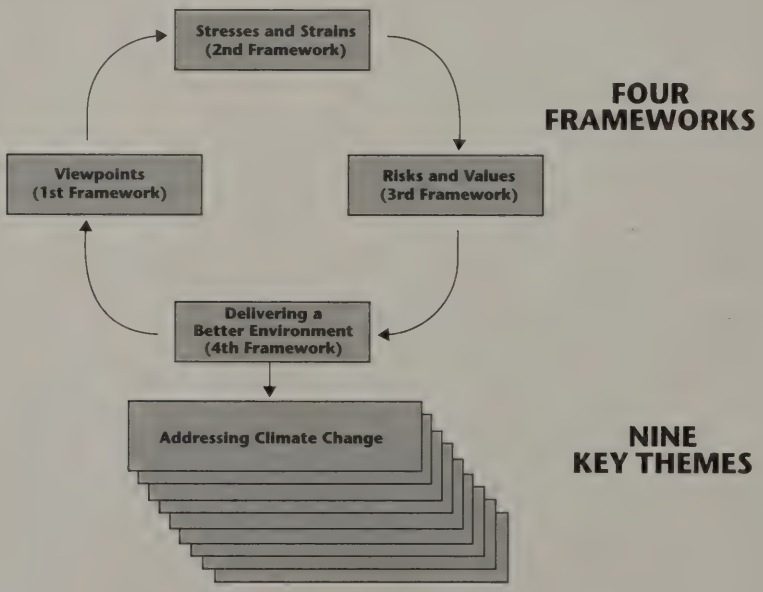
- addressing climate change
- regulating major industries
- improving air quality
- managing waste
- managing our water resources
- delivering integrated river-basin management
- conserving the land
- managing our freshwater fisheries
- enhancing biodiversity

The frameworks and key environmental themes are set out in Sections 3.2 to 3.13 below. As part of the transition to this new approach, the commissioned programme outputs for 1997/98 are reported under the most relevant framework or theme.

Appendix 2 provides a complete list of outputs produced by the Agency's R&D programme in 1997/98, together with their availability, and cross-referenced to the frameworks and themes. Where the implementation of an output is still under consideration by the Agency, where it contains commercial-in-confidence information, or where it feeds into another activity such as the development of a functional manual, its current availability may be restricted. External organisations wishing to know more about such outputs should contact the relevant programme officer, as listed in Appendix 1.

Projects ongoing in 1997/98 are listed in Appendix 3 within the frameworks and themes structure.

Figure 3.1
Frameworks and Key Environmental Themes


Stresses and Strains (2nd Framework)
FOUR FRAMEWORKS
Viewpoints (1st Framework)
Risks and Values (3rd Framework)
Delivering a Better Environment (4th Framework)
Addressing Climate Change
NINE KEY THEMES

3.2 The Viewpoints Framework

3.2.1 Viewpoints Framework for the State of the Environment

The environment is a key resource for society and industry. Well-informed decisions about how to protect, maintain and improve it require an understanding of its overall state and of the processes essential to its well-being. "Viewpoints" will provide a framework for gathering and presenting the Agency's data on the state of the environment, and interfacing it with that of other organisations in different scales of space (local, regional, national, global) and time. R&D will assist the Agency in developing and establishing this framework.

The Agency uses six "viewpoints" from which to describe the state of the environment and the well-being of those who live in it – (i) land use and resources; (ii) key biological populations and communities; (iii) compliance with standards and targets; (iv) environmental health, including human well-being; (v) long-term reference sites; (vi) aesthetic quality. Effective techniques are essential for observing, determining, presenting and utilising key attributes of these indicators.

The current state of the environment includes the diversity between and within ecosystems and habitats, the diversity of species (for example the number of species of fish within any river); and the genetic pools within species.

3.2.2 The Agency will use R&D to:

- develop effective means of monitoring the environment from the different viewpoints;
- explore, with others, different ways of monitoring the health of the environment;
- develop, with others, ways of measuring long-term changes to the environment;
- develop co-ordinated approaches to monitoring at local, regional and national levels;
- develop readily understandable ways of presenting data on the state of the environment;
- explore the opportunities for using remotely sensed data, including satellite imagery;
- work with others who also measure the environment to make best use of all data;
- report on the UK environment with our partners in Scotland and Northern Ireland.

3.2.3 Outputs

This section lists the nine outputs produced in 1997/98 that are most relevant to this framework, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those ouputs available to the general public.

The principal outputs that fall within the Viewpoints framework are:

Project Record E1/001/2
Instrumentation for Self Monitoring: A Legal Review

Technical Report E33
Strategy for Auditing the Self-Monitoring Programme

Technical Report E9
National Database of Recreational Fresh Water Quality – Scoping Study

Technical Report E62
Final Report on the Acid Waters Survey for Wales: Volume 1, Main Text

Technical Report P53
Aquatic Litter Information System Using Digital Technologies

Technical Report P73
Corporate Environmental Reporting in the UK Water Sector – A Concise Review

Note 440
The Current Monitoring Strategies in Selected Member States

Note 477
Self-Monitoring of Effluent Discharges – Current Strategies Used in Selected Member States and the USA

Publications
Coasts and Seas of the United Kingdom – Coastal Directories, Volumes 1-17

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report E33

Strategy for Auditing the Self-Monitoring Programme

Osborne M J (1997)

Metoc plc

Project No. E1-001

Commissioned Programme: Environmental Monitoring and Assessment

The Agency has a duty to implement the requirements of the Urban Waste Water Treatment Directive (UWWTD) in a manner that imposes a minimal cost on itself and the dischargers. This includes self-monitoring requirements based on the analysis of samples of sewage works influent and effluent taken by automatic composite sampling. It is essential that the automatic sampling equipment can take representative samples of the process stream and maintain the integrity of the monitored determinands during the storage period before analysis. It is also essential that the many suitable sampling processes are subject to checking by the Agency to ensure the data are of acceptable quality.

The purpose of this project was to review the automatic instrument requirements of the UWWTD, produce a specification of a suitable instrument and develop an audit strategy for ensuring that it is correctly used and applicable to a large number of self-monitoring dischargers.

This document suggests ways in which self-monitoring for UWWTD purposes can be audited to a suitable standard at minimal cost to the discharger and regulator. It proposes that the discharger develops a quality system and submits the manual to the Agency for approval. It also outlines an inspection procedure.

Technical Report E32: Specification for Automatic Sampling Equipment for the UWWTD is another output from this project.

Publication Ref: R&D Technical Report E9

National Database of Recreational Fresh Water Quality – Scoping Study

Fewtrell L and Kay D (1997)

Centre for Research into Environmental Health

Project No. E1-620

Commissioned Programme: Environmental Monitoring and Assessment

The Agency, local authorities, British Waterways and water companies hold data on the microbiology of recreational fresh waters. There has previously been no way of accessing this data for the purpose of regional and national investigations or for the reporting of trends.

The aims of the scoping study were to:

- find out which organisations hold data, and set up a liaison route between them;
- discover how the data can be retrieved;
- recommend how the Agency might use this data.

Of the 307 local authorities that responded to the request for information, 79 conduct microbiological monitoring of fresh water recreational sites. All would be willing to share their data with the Agency. Midlands was the only Agency region to routinely monitor these waters, while a number of other regions do not distinguish between recreational and non-recreational sites in their monitoring. The majority of water companies do not monitor recreational sites unless they are used for drinking water abstraction.

The scoping study evaluates existing sources of data, their locations, size of datasets, storage media and availability. It concludes that it would be possible to bring these data together to provide public register information of bacteriological fresh water quality, and that this would be a valuable resource.

Publication Ref: R&D Technical Report E62

Final Report on the Acid Waters Survey for Wales: Volume 1, Main Text

Stevens P A, Ormerod S J and Reynolds B (1997)

Institute of Terrestrial Ecology and University of Wales

Project No. E1-672

Commissioned Programme: Environmental Monitoring and Assessment

Sulphur emissions and deposition have declined in Europe over the last decade, but evidence of recovery in formerly acidified surface waters is scarce. This may simply reflect a slow response, but the increasing importance of acidic nitrogen deposition must also be recognised.

Welsh lakes and streams lie across a large acid-sensitive area and provide a strong indicator of environmental acidification. In 1983/84 the former Welsh Water Authority surveyed more than 140 streams and measured deposition rates across Wales.

A recent review recommended that the survey be repeated to assess any changes in deposition and streamwater chemistry since 1984. It would also assess the biological status of freshwaters, examine the validity of current models, and provide a database for examining the effects of catchment characteristics, particularly forestry.

The work was jointly funded by the Agency, the Welsh Office, the Countryside Council for Wales and the Forestry Authority. The detailed results are contained in this report.

Publication Ref: R&D Technical Report P53

Aquatic Litter Information System Using Digital Technologies

Earll R, Hall G, Statter T and Marriott S (1997)

University of the West of England

Project No. P2-027

Commissioned Programme: Water Quality

There is a growing awareness that aquatic litter is a very costly and damaging form of pollution. Its management should be based on sound information, with the understanding that establishing its source enables the development of effective preventative measures.

This project was undertaken to create a prototype of an information system for identifying aquatic litter. This would be on CD-ROM, with the potential for use on the World Wide Web. In the past the use of photographs for information manuals has been limited by high publication costs, but modern digital technologies have removed that constraint.

The resulting aquatic litter information system (ALIS) contains linked volumes of text and images, with an emphasis on the latter. The development of the project, and particularly the use of photographic images, prompted a reappraisal of how sourcing aquatic litter could be undertaken, and this part of the guide was orientated at socio-economic and input sources, rather than identifying individual items.

It is recommended that information systems on an internet site could be a significant way to enable access and add value to project information.

Publication Ref: R&D Technical Report P73

Corporate Environmental Reporting in the UK Water Sector – A Concise Review

Hunt D T E (1997)

WRc plc

Project No. P2-050

Commissioned Programme: Water Quality

Corporate Environmental Reports (CERs) provide information about environmental management, objectives and performance. The number published is increasing, but there is considerable variation in their approach, scope, content and style. This study reviewed CERs from the UK water industry with the aim of:

- identifying similarities and differences in their scope and approach;
- considering their potential value to the Agency;
- making recommendations for improving their quality and comparability.

Consideration was also given to how far the findings are applicable to other sectors.

This report concludes that the water sector is well advanced in terms of the number of companies that publish CERs. However, the content and detail of the documents vary, and the report identifies areas of benefit and weakness. CERs facilitate environmental improvement through communication and concept transfer, and could be an aid to the Agency's promotion of sustainable development. Where there is a convergence of reporting practices, there may be sufficient industry coverage for sectoral aggregation. This is of potential benefit to the sector for benchmarking purposes, and to the Agency for facilitating "state of the environment" reporting.

The report makes recommendations to the water sector and the Agency regarding the future development and use of CERs.

Publication Ref: R&D Note 477

Self-Monitoring of Effluent Discharges – Current Strategies Used in Selected Member States and the USA

Barry M *et al* (1995)

WRc plc

Project No. P2-051

Commissioned Programme: Water Quality

Project P2-501 examined pollution control practice in other countries with a view to assisting the Agency in formulating policy.

This report reviews approaches to the self-monitoring of effluents in France, Germany, the Netherlands and the USA, where legislation has been introduced requiring most industrial and municipal dischargers to be self-monitored. It explains each country's procedures and requirements, including its response to exceedances.

All four countries have adopted a self-monitoring regime as a means of raising dischargers' awareness of the effluents they produce, collect, treat and discharge. All maintain a significant compliance monitoring programme to verify the results of the dischargers' own programmes and to ensure that self-monitoring is sufficiently rigorous to protect the receiving waters.

Publication Ref: R&D Publications

Coasts and Seas of the United Kingdom – Coastal Directories, Volumes 1-17

Edited by Barne J H *et al* (1998)

Joint Nature Conservation Committee

Project No. W5-518

Commissioned Programme: Flood Defence

This project supported the Joint Nature Conservation Committee (JNCC) in its development of a series of directories of coastal information.

The JNCC-led research resulted in a series of regional directories, each containing an introduction followed by chapters on: geology and physical environment; terrestrial coastal habitats; marine and estuarine environments; important species; history and archaeology; coastal protected sites; land use, infrastructure and coastal defence; human activities; coastal management.

Volumes are as follows:

1 Shetland
2 Orkney
3 North-east Scotland: Cape Wrath to St Cyrus
4 South-east Scotland: Montrose to Eyemouth
5 North-east England: Berwick-on-Tweed to Filey Bay
6 Eastern England: Flamborough Head to Great Yarmouth
7 South-east England: Lowestoft to Dungeness
8 Sussex: Rye Bay to Chichester Harbour
9 Southern England: Hayling Island to Lyme Regis
10 South-west England: Seaton to the Roseland Peninsula
11 The Western Approaches: Falmouth Bay to Kenfig
12 Wales: Margam to Little Orme
13 Northern Irish Sea: Colwyn Bay to Stranraer
14 South-west Scotland: Ballantrae to Mull
15 & 16 Western Isles and West Highland
17 Northern Ireland

The reports are also available in electronic format, supplied with Windows-compatible reader software.

3.3 The Stresses and Strains Framework

3.3.1 Stresses and Strains Framework for Pressures on the Environment

Understanding what pressures – man-made or natural – are acting on the environment is an essential step to deciding how best to manage it. The success of the Agency in protecting and improving the environment will be judged largely by how effectively it controls key pressures on it. The Agency is developing a "Stresses and Strains" framework – complimentary to its "Viewpoints" – for interfacing data on the state of the environment and the pressures on it. The pressures can be thought of as different sets of *stresses*, and the manner in which these affect the state of the environment as causing different *strains* upon it. As with Viewpoints, the Agency requires effective techniques for observing, determining, presenting and utilising indicators of these pressures. The Agency's LEAPs and its report on the state of the environment (see Web site) are key means of involving others in controlling and reducing these pressures. R&D will assist the Agency in developing and establishing this framework.

The Agency utilises six indicators of pressures, reflecting its direct responsibilities for regulation of a wide range of environmental licences and for other operational activities. These are: (i) natural forces, including climate variations; (ii) societal influences, including population pressure, energy consumption, transport, change in land use, and public perception; (iii) abstractions and removals of natural resources; (iv) usage, releases and discharges with potential to impact on the environment; (v) waste arisings and disposals; (vi) illegal practices, including accidents and non-compliance with regulations.

In many of these areas, the ability to predict the effects of future pressures depends on understanding not only environmental systems but also the way in which society responds to changing economic and environmental states, thereby placing further pressures on the environment.

3.3.2 The Agency will use R&D to:

- research/understand the full range of direct and indirect stresses on the environment;
- assess how these stresses vary in time and from one part of England and Wales to another;
- research/understand the pathways, fates and effects of key stresses on the environment;
- develop ways of monitoring and screening the environment for new hazardous substances;
- encourage all relevant research institutions to monitor their environment for local stresses;
- encourage those with potential to damage the environment to monitor their relevant activities;
- develop new and effective ways of reporting on stresses and strains in LEAPs.

3.3.3 Outputs

This section lists the 20 outputs produced in 1997/98 that are most relevant to this framework, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those ouputs available to the general public.

The principal outputs that fall within the Stresses and Strains framework are:

Project Record E1/001/1
A Review of Automatic Samplers and Waste Water Monitoring Equipment

Technical Report E32
Specification for Automatic Sampling Equipment for the UWWTD

Project Record E1/008/1
Analysis of 1995 Survey Data and RIVPACS Update – Consultation Process for the Development of the Phase 2 Schedule of Research

Technical Report E26
RIVPACS III and User Manual including software

Technical Report E35
Operating Manual for Moored Marine Monitor

Technical Report E15
New Sampling and Analytical Methods: Pesticides and Transformation Products in Chalk Aquifers

Note 435
Analytical Method for the Determination of Triazine Herbicides and their Transformation Products in Chalk Aquifer Material

Note 436
Analytical Method for the Determination of Isoproturon and its Transformation Products in Chalk Aquifer Material

Technical Report E21
Method Development for Chromium (III) and (VI) in Seawater

Technical Report E22
Measurements of Residual Oxidants

Project Record E1/i700/1
Measurements of Residual Oxidants

Technical Report E45
Evaluation of Mini Metal Sensors Phase 2

Technical Report P84 (MTF Report 29)
Report of the UK Mirror Task Force: Environment – Water

Technical Report P111
Remote Surveillance of Mineral Extraction Discharges

Technical Report P112
Review of Colour Monitoring Techniques

Technical Report P32
Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources

Technical Report P33
Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources – Literature Review

Project Record P2/i662/03
Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources – Literature Review

Technical Report W47
Strategic Remote Sensing of Coastal Types: Feasibility Study Part 1: Executive Summary and Outline Report

Technical Report W56
Strategic Remote Sensing of Coastal Types: Feasibility Study Part 2: Main Report and Appendices

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report E32

Specification for Automatic Sampling Equipment for the UWWTD

Osborne M J (1997)

Metoc plc

Project No. E1-001

Commissioned Programme: Environmental Monitoring and Assessment

The Agency has a duty to implement the requirements of the Urban Waste Water Treatment Directive (UWWTD) in a manner that imposes a minimal cost on itself and the dischargers. This includes self-monitoring requirements based on the analysis of samples of sewage works influent and effluent taken by automatic composite sampling. It is essential that the automatic sampling equipment can take representative samples of the process stream and maintain the integrity of the monitored determinands during the storage period before analysis. It is also essential that the many suitable sampling processes are subject to checking by the Agency to ensure that the data are of acceptable quality.

The purpose of this project was to review the automatic instrument requirements of the UWWTD, produce a specification of a suitable instrument and develop an audit strategy for ensuring that it is correctly used and applicable to a large number of self-monitoring dischargers.

This specification examines the requirements of the UWWTD, refers to relevant international and British standards, and develops appropriate tests for equipment. It is based on knowledge of the performance of commercially available equipment and can be met by a number of existing products.

Technical Report E33: Strategy for Auditing the Self-Monitoring Programme is another output from this project.

Publication Ref: R&D Project Record E1/008/1

Analysis of 1995 Survey Data and RIVPACS Update – Consultation Process for the Development of the Phase 2 Schedule of Research

Furse M T and Clarke R T (1997)

Institute of Freshwater Ecology

Project No. E1-008

Commissioned Programme: Environmental Monitoring and Assessment

During 1995, Agency biologists visited approximately 8,000 river sites to sample their macro-invertebrate communities. The resulting information was used to grade each site according to the new general quality assessment (GQA) biological classification.

Phase 2 of this project will examine the distribution of invertebrates in relation to a number of environmental factors, including pollution, and consider spatial and temporal trends in the ecological quality of rivers.

Phase 1 aimed to:

- carry out a scoping study and prepare a project initiation document for Phase 2;
- produce a new module for the river invertebrate prediction and classification system (RIVPACS) for Agency use and data analysis during Phase 2.

This report contains details of a consultation exercise with regard to options for utilising the biological data collected during the 1995 GQA. The results will guide data analysis in Phase 2.

Publication Ref: R&D Technical Report E15

New Sampling and Analytical Methods: Pesticides and Transformation Products in Chalk Aquifers

Clark L *et al* (1997)

WRc plc

Project No. E1-533

Commissioned Programme: Environmental Monitoring and Assessment

Greater understanding is required of the mechanisms by which pesticides enter groundwater after application for weed control. As a first step, methodologies are needed for detecting these compounds and their degradation products in solid aquifer material. This study, funded by the Agency and the European Commission DG-XII, aimed to develop, validate and use sampling and analytical methods for this purpose.

A literature review identified environmental transformation products (TPs) of many high-usage pesticides, several of which have been reported in significant quantities in water levels in the UK. Laboratory development and validation produced analytical methods based on liquid chromatography-mass spectrometry (LC-MS) for the principal TPs of atrazine and isoproturon in chalk aquifer material.

This report provides details of the work. It concludes that agricultural herbicides have the potential to migrate through unsaturated material and infiltrate groundwater where there is fissure flow or high flux rates, and that the major TPs of atrazine can, under certain hydrogeological conditions, present a risk to groundwater quality. This has important implications for pesticide use in the agricultural environment.

Other outputs from this project are:

R&D Note 435: Analytical Method for the Determination of Triazine Herbicides and their Transformation Products in Chalk Aquifer Material

R&D Note 436: Analytical Method for the Determination of Isoproturon and its Transformation Products in Chalk Aquifer Material

Publication Ref: R&D Note 435

Analytical Method for the Determination of Triazine Herbicides and their Transformation Products in Chalk Aquifer Material

Moore K M, Franklin O and Hegarty B F (1995)

WRc plc

Project No. E1-533

Commissioned Programme: Environmental Monitoring and Assessment

This work is part of a study, funded by the Agency and the European Commission DG-XII, to develop analytical techniques for detecting certain pesticides and their transformation products (TPs) in aquifer materials.

The report describes the development and validation of an analytical method for detecting atrazine, simazine and their TPs in chalk aquifer material. The method is based on the principle of acetone extraction, filtration and determination by high-performance liquid chromatography-mass spectrometry (HPLC-MS). Considering the difficult nature of the analysis, it achieves good accuracy and limits of detection. It is the first analytical method known to be reported for pesticide TPs in aquifer material.

Further details of the project are recorded in *R&D Technical Report E15: New Sampling and Analytical Methods: Pesticides and Transformation Products in Chalk Aquifers.*

R&D Note 436: Analytical Method for the Determination of Isoproturon and its Transformation Products in Chalk Aquifer Material is an associated output.

Publication Ref: R&D Note 436

Analytical Method for the Determination of Isoproturon and its Transformation Products in Chalk Aquifer Material

Moore K M, Franklin O and Hegarty B (1996)

WRc plc

Project No. E1-533

Commissioned Programme: Environmental Monitoring and Assessment

This work is part of a study, funded by the Agency and the European Commission DG-XII, to develop analytical techniques for detecting certain pesticides and their transformation products (TPs) in aquifer materials.

This report describes the development and validation of an analytical method for detecting isoproturon and its TPs in chalk aquifer material. The method is based on the principle of acetone extraction, filtration and determination by high-performance liquid chromatography-mass spectrometry (HPLC-MS). Considering the difficult nature of the analysis, it achieves good accuracy and limits of detection. Because the method for isoproturon and its TPs is similar to that previously developed for triazine herbicides and their TPs, it might be possible to analyse both sets of determinands in the same extract.

Further details of this project are recorded in *R&D Technical Report E15: New Sampling and Analytical Methods: Pesticides and Transformation Products in Chalk Aquifers.*

R&D Note 435: Analytical Method for the Determination of Triazine Herbicides and their Transformation Products in Chalk Aquifer Material is an associated output.

Publication Ref: R&D Technical Report E21

Method Development for Chromium (III) and (VI) in Seawater

Griffiths E W and Hughes D A (1998)

Environment Agency Laboratory, Llanelli

Project No. E1-626

Commissioned Programme: Environmental Monitoring and Assessment

Chromium VI (Cr VI) has been identified as a potential pollutant of the aquatic environment. Few analytical techniques exist for its determination in seawater at its natural level of less than 0.05 μg/l. This study aimed to develop an analytical method based on voltammetric techniques to determine chromium speciation in seawater and to produce a written procedure.

Adsorptive cathodic stripping voltammetry (ACSV) showed a distinct advantage over anodic stripping voltammetry (ASV), and a method is described for determining total dissolved chromium by ACSV.

Speciation analysis of chromium proved difficult because it could not be stored and only immediate analysis of samples gave accurate results for Cr (III) and Cr (VI). Two speciation methods were investigated. The report recommends that the Agency uses the more reliable of these, with speciation taking place immediately after sampling. It also suggests areas of further research.

Publication Ref: R&D Technical Report P84 (MTF Report 29)

Report of the UK Mirror Task Force: Environment - Water

Foundation for Water Research (1997)

Project No. P2-017

Commissioned Programme: Water Quality

The European Commission has introduced task forces as a means of achieving a consensus among its directorates-general on European research priorities. This includes the task force "Environment – Water".

To identify national priorities, the mirror task forces (MTFs) were set up. The DETR, the Agency and the Scottish Environment Protection Agency sponsored the UK MTF on Environment – Water.

The UK MTF operated on an independent basis, consulting with professional and research organisations, public and non-governmental bodies, the water industry and its suppliers.

This report sets out the themes recommended for pan-European research programmes:

- ecological quality of freshwaters;
- effect of land use, with special reference to agriculture;
- disinfection of public water supplies
- integrated river basin management;
- impact of climate change on the water environment;
- informing and educating the consumer.

The report focuses on areas where R&D could build on the results of existing scientific research. The aim is to provide water management tools and performance standards capable of maintaining the leading position of European technology and environmental management practices.

Publication Ref: R&D Technical Report P111

Remote Surveillance of Mineral Extraction Discharges

Long T M and Allen R C (1998)

National Centre for Environmental Data and Surveillance

Project No. P2-022

Commissioned Programme: Water Quality

Civil engineering projects that move large quantities of soil and rock, such as open cast mining, can give rise to transient discharges of pollutants to controlled waters.

This project assessed the potential of airborne remote surveillance to overview the condition of such discharges so that ground inspection resources could be focused selectively on problem areas.

This final report concludes that a combination of airborne spectographic imaging and photography can identify surface water, treatment processes and discharges to watercourses in open cast coal workings. It adds nothing, however, to the effectiveness of ground inspection and is therefore best used to overview sites where routine personal inspection does not take place. The report also concludes that spectographic imaging can identify areas of stressed vegetation and, by implication, the extent of contamination of its associated land and surface water.

Recommendations are made for further investigating the potential of remote surveillance and techniques employing synoptic overview.

Publication Ref: R&D Technical Report P112

Review of Colour Monitoring Techniques

Skelly J K and Long T M (1998)

Environment Agency In-house

Project No. P2-020

Commissioned Programme: Water Quality

The discharge of coloured effluents from textile processing plants is a problem that may increase with changes in processing and dye formulations. The majority of discharges are to sewerage, but treatment processes are not always successful in removing residual colour, and new dye formulations may be more resistant to degradation.

This study aimed to:

- review textile processes and their influence on effluent colour;
- predict future trends in textile processing and their likely effects on effluent colour;
- investigate end-of-pipe and sewage treatment techniques that could remove problem colours.

The report concludes that the main change in textile processing is likely to be the growth of cottonwear dyed with cellulose-reactive dyes. Improvements in textile processing best practice may reduce the total volume of effluent, thereby increasing colour concentration. To remove colour, the report identifies several end-of-pipe and sewage treatment processes. It proposes on-site treatments and recycling effluent as the best ways forward.

Publication Ref: R&D Technical Report P32

Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources

Chilton P J *et al* (1996)

British Geological Survey

Project No. P2-662

Commissioned Programme: Water Quality

Nitrate pollution of groundwater from agricultural land use is relatively well understood, and control measures such as Nitrate Vulnerable Zones (NVZs) have been introduced. There are concerns, however, that other local sources of pollution may also be significant. These are less well understood and therefore difficult to evaluate.

This project aimed to provide better technical understanding of non-agricultural sources of nitrogen, including their nature, magnitude and pathways. It would also provide simple, technically robust methodologies for assessing their contribution on an individual catchment basis.

Existing work on the topic is reviewed and collated and methodologies presented for assessing the relative contribution from individual sources.

The project identifies potentially important sources of nitrates, but highlights uncertainty regarding their scale and the degree of mobilisation of nitrogen (that is, conversion to nitrate). This may limit the application of the methodologies, or in some circumstances require further data.

This report describes the methods for assessment of individual sources of non-agricultural nitrogen and demonstrates their application through case studies.

Technical Report P33 contains the associated literature review.

Publication Ref: R&D Technical Report P33

Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources – Literature Review

Coleby L M *et al* (1996)

British Geological Survey

Project No. P2-662

Commissioned Programme: Water Quality

Nitrate pollution of groundwater from agricultural land use is relatively well understood, and control measures such as Nitrate Vulnerable Zones (NVZs) have been introduced. There are concerns, however, that other local sources of pollution may also be significant. These are less well understood and therefore difficult to evaluate.

This project aimed to provide better technical understanding of non-agricultural sources of nitrogen, including their nature, magnitude and pathways. It would also provide simple, technically robust methodologies for assessing their contribution on an individual catchment basis.

Existing work on the topic is reviewed and collated and methodologies presented for assessing the relative contribution from individual sources.

This report contains the literature review. *Technical Report P32* describes the methods for assessment of individual sources of non-agricultural nitrogen and demonstrates their application through case studies.

Publication Ref: R&D Technical Report W47

Strategic Remote Sensing of Coastal Types: Feasibility Study Part 1: Executive Summary and Outline Report

Fuller R M, Thomson A G and Eastwood J A (1997)

Institute of Terrestrial Ecology

Project No. W5-730

Commissioned Programme: Flood Defence

The effective management of the coastline for flood defence and conservation requires strategic monitoring of the coastal zone of England and Wales. The Agency particularly needs qualitative and quantitative information on coastal and estuarine environments that change with time.

This programme of work investigates the use of remote sensing methods for the provision of suitable maps and data. The feasibility study determined the Agency's needs, so that a suitable programme of work could be developed using available remote sensing techniques and expertise. The CASI (compact airborne spectral imager) platform was chosen for investigation because it has already been used successfully in water quality monitoring, river corridor surveys and sediment tracking.

The study identified key coastal land types and investigated the ability of CASI to provide the necessary data.

It is recommended that 5-10m CASI images be evaluated and analytical methods developed for full strategic coastline monitoring. The report outlines the aims and procedure for the method development.

The report is produced in two volumes. Part 1 gives the executive summary and outline report. Part 2 – *Technical Report W56* – contains the main report and appendices.

Publication Ref: R&D Technical Report W56

Strategic Remote Sensing of Coastal Types: Feasibility Study Part 2: Main Report and Appendices

Fuller R M, Thomson A G and Eastwood J A (1997)

Institute of Terrestrial Ecology

Project No. W5-730

Commissioned Programme: Flood Defence

The effective management of the coastline for flood defence and conservation requires strategic monitoring of the coastal zone of England and Wales. The Agency particularly needs qualitative and quantitative information on coastal and estuarine environments that change with time. This programme of work investigates the use of remote sensing methods for the provision of suitable maps and data.

The findings of the feasibility study – explained under *Technical Report W47* – are provided in this report, which is in two volumes. *Technical Report W47* contains the executive summary and outline report, while this (*Technical Report W56*) provides the main report and appendices.

3.4 The Risks and Values Framework

3.4.1 Risks and Values Framework for Identifying the Options

The Agency's third decision-making framework enables it to resolve the environmental issues and problems that arise from looking at the "Stresses and Strains". This is therefore a framework less for presentation of data than for presenting the various tools and techniques that can be applied to these data sets in determining the appropriate management response. In most cases, this involves considering *risk* (actual or perceived) in one way or another. The response depends on the *values* placed upon these risks by the Agency or others. R&D will assist the Agency in developing and establishing this framework.

The Agency recognises three different types of *risk*: (i) risks that are inherent in the environment, but can be reduced (for example, flooding or drought); (ii) risks that are new, and arise from its powers as a regulator to issue environmental licences; (iii) risks that may not arise until some time in the future (for example, some aspects of radioactive waste disposal). The Agency will consider *values* in four ways: (i) where the benefits are not in question (for example, with statutory duties), by using cost-effectiveness techniques; (ii) where the benefits can be chosen and costed, by using cost-benefit techniques; (iii) where the bulk of valuation cannot be expressed in monetary terms and new techniques need to be developed, such as multi-attribute techniques; (iv) where the use of consensus-building approaches can involve a wider public in valuing the environment.

The forecasting of the likely future state of the environment resulting from various stresses upon it – at whatever level – is inherently difficult. Environmental models will be used to predict and examine different future scenarios so that the Agency can choose the most appropriate response. The tools and techniques needed to assess future scenarios and options for response must incorporate a risk-based approach

3.4.2 The Agency will use R&D to:

- understand the environment's capacity for absorbing and responding to different stresses;
- assess the likely future stresses and the severity of risks facing the environment;
- predict likely changes in the state of the environment in the light of possible future stresses;
- draw together and develop new ways of forming an opinion on the state of the environment;
- draw together and develop robust techniques and data for valuing the environment;
- develop ways of determining who should pay for environmental protection and improvement;
- understand the public's perception of, and wish to be pro-active in, environmental issues.

3.4.3 Outputs

This section lists the 17 outputs produced in 1997/98 that are most relevant to this framework, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those ouputs available to the general public.

The principal outputs that fall within the Risks and Values framework are:

Technical Report E44
Resource Demand Management Techniques for Sustainable Development

Technical Report E46
Green Household Index – The Eco-Cal

Technical Report E65 (AEAT-1924)
Management of Harm to the Environment: Final Report

Project Record E2/238/1
DEMIS Initial Development Project

Project Record E2/238/2
DEMIS Introduction Manual

Project Record E2/238/3
DEMIS Reference Manual

Technical Report P172 (CWM 151/96)
Perceptions and Communication: Issues for Waste Management

Project Record P2/063/1
PRAIRIE™ Protocol

Technical Report P68
PRAIRIE™ Guidance

Technical Report P69
Development of PRAIRIE™ Dispersion Modelling

Technical Report P70
Updating of PRAIRIE™ Databases

Technical Report W77
Review of Natural Resource Plans and Development Programmes

Project Record W4/i641/1
Review of Natural Resource Plans and Development Programmes

Technical Report W32
A Methodology for Community Involvement in LEAPs

Project Record W4/i680/6
A Methodology for Community Involvement in LEAPs

Technical Report W13
Review of Lone Worker Beacon

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report E44

Resource Demand Management Techniques for Sustainable Development

Environmental Resources Management (1998)

Project No. E2-005

Commissioned Programme: Sustainable Development

Increasing demand for services such as water, energy and waste disposal can be met either by expanding supply or by managing demand. Resource Demand Management (RDM) seeks to ensure that the right balance of demand- and supply-side options is achieved. Since past decision-makers have often concentrated resources too heavily on supply, RDM typically leads to more investment on the demand side, and often brings environmental and economic benefits.

The Agency is developing a range of techniques for implementing the elements of sustainable development. This study was set up, therefore, to investigate the effectiveness of RDM techniques, and to assess their suitability for the Agency's purposes.

The study reviews existing RDM techniques and assesses their applicability to the Agency's roles and responsibilities. It outlines the institutional and structural frameworks necessary for their operation, and makes recommendations for action by the Agency.

Publication Ref: R&D Technical Report E46

Green Household Index – The EcoCal

Sutton J (1997)

Going for Green Ltd

Project No. E2-007

Commissioned Programme: Sustainable Development

The Agency and Going for Green shared the costs of researching and developing a tool – the EcoCal – for householders to measure their environmental impacts. Details of the process are contained in this report.

Formulae were developed to quantify the environmental impacts of each household activity, and to calculate the ecological footprint of each impact. Questions were produced that would be easy for householders to answer and supply the details necessary to calculate the EcoCal score.

The first paper and computer versions of EcoCal were subjected to a month of market testing, resulting in a number of changes. The launch was highly successful, with considerable media coverage and an enthusiastic public response.

The "eco-calorie" is a powerful tool for providing personalised information about household environmental impacts and for encouraging individual behaviour and lifestyle changes.

Publication Ref: R&D Technical Report E36

What Matters and Why – Environmental Capital: A New Approach

CAG Consultants (1997)

Project No. E2-009

Commissioned Programme: Sustainable Development

The notion of "environmental capital" – whereby the environment is viewed as a number of assets providing benefits – has become influential and widely used. The usual division into "critical", "constant" and "tradeable" environmental capital reflects the view that some assets are more important than others.

The concept has, however, proved surprisingly difficult to use. Environmental assets do not fit neatly into one category, and the distinction between "critical", "constant" and "tradeable" does not always help in practical management. Different organisations have codified and applied the concept in different ways, resulting in inconsistencies that have reduced its credibility.

The Countryside Commission, English Nature, English Heritage and the Agency recognised the need for a new approach. They entered into a collaborative project drawing on their own expertise and that of government departments, planning authorities and others.

Rather than considering environmental features or sites, the new approach considers the functions they perform, or the services they provide. It asks questions about the characteristics or attributes of a given place or object that are significant for sustainability. The answers determine the management action necessary to protect and/or enhance each attribute.

The project finds a number of benefits in the new approach, and identifies a range of applications. These include structure plans, nature conservation strategies, site management plans, and informing consideration of development control or land use proposals.

A provisional guide to the new approach is given, with the intention that this will be trialled in a range of situations.

Publication Ref: R&D Project Record E2/238/2

DEMIS Introduction Manual

Vine M and Nalpanis P (1997)

Det Norske Veritas

Project No. CPR2/41/1/238

Commissioned Programme: Sustainable Development

DEMIS (Distributed Environmental Management Information System) is a decision support tool for assisting in the solution of strategic and operational environmental and risk issues. The initial version supplied to the Agency was OHRAT (Offshore Hazard Risk Analysis Toolkit), which contained some models and tools not applicable to the Agency's regulatory business.

This project aimed to develop a prototype version of DEMIS to demonstrate its potential range of applications for the Agency.

A prototype was developed and demonstrated through a "non-routine releases" case study. Results were of a level of complexity unattainable with any other modelling approach available to the Agency. Several key regulatory requirements can be achieved within a single modelling environment.

This manual provides an introduction to the DEMIS toolkit. *Project Record E2/238/3: DEMIS Reference Manual* gives further details on its use.

Project Record E2/238/1: DEMIS Initial Development Project is an associated output.

Publication Ref: R&D Technical Report P172 (CWM 151/96)

Perceptions and Communication: Issues for Waste Management

Petts J *et al* (1996)

Loughborough University
PDA International
Environmental Resources Management

Project No. P1-211

Commissioned Programme: Waste Regulation and Management

The aim of this project was to produce practical guidance on public perceptions of waste management and communication relevant to all parties involved in the planning, siting, operation and regulation of waste facilities.

The study included:

- a review of international literature on public perceptions and communications;
- a discussion meeting with representatives of waste companies and local authorities;
- a survey of interest groups;
- a review of current communication practice.

The study recommends that communication should, firstly, promote confidence and trust in authorities, the industry and decision processes and, secondly, seek consensus on the means of achieving sustainable waste management. It suggests aspects of communication for consideration by the Agency, and techniques that might be effective.

To achieve the longer term objectives of waste management, decision-making and waste management operations should be open, accountable and responsive to the legitimate and rational concerns of the public. The inclusion of all stakeholders in decision-making should optimise the potential to achieve consensus on sustainable waste management.

Publication Ref: R&D Project Record P2/063/1

PRAIRIE™ Protocol

Sutherland P M, White P G and Caley J (1997)

WS Atkins Consultants Ltd

Project No. P2-063

Commissioned Programme: Water Quality

PRAIRIE™ – Pollution Risk from Accidental Influxes into Rivers and Estuaries – is a software package designed for the assessment of risks to water quality from chemical spills into rivers.

This protocol provides guidance for operational staff in the Agency as to when PRAIRIE™ software should be used. It includes background information on the software and its development, and a description of its basic structure and application. This is followed by a simple hypothetical case study.

A short summary of the protocol – a provisional version of which is provided in an appendix – is intended for inclusion in the risk assessment section of the Agency's Pollution Prevention Manual.

Along with a package of PRAIRIE™ enhancements *(R&D Technical Reports P68, P69, P70)*, this project should increase the value of the software to officers responsible for protecting potable water supplies and the environment from the effects of accidental chemical spills.

Publication Ref: R&D Technical Report P68

PRAIRIE™ Guidance

Watson A, Clark J W and Fryer L S (1997)

AEA Technology

Project No. P2-707

Commissioned Programme: Water Quality

This project aimed to enhance earlier versions of PRAIRIE™ by:

- providing additional guidance to supplement the software user manual;
- expanding and updating the substance database within PRAIRIE™;
- evaluating the use of alternative dispersion models within PRAIRIE™.

This guidance document has been produced as an aid to occasional or first-time users of PRAIRIE™ who do not require the detailed information available in the user's guide or the modelling report. Simple examples give sufficient information to run the code successfully and obtain meaningful results. Guidance is also given on how to use the PRAIRIE™ databases to maximum effect.

This project is complementary to Project P2-063, which has the objective of producing a of PRAIRIE™ Protocol. Together they should increase the value of PRAIRIE™ to officers responsible for protecting potable water supplies and the environment from the effects of accidental chemical spills.

Other outputs from this project are:

R&D Technical Report P69: Development of PRAIRiE™ Dispersion Modelling

R&D Technical Report P70: Updating of PRAIRIE™ Databases

Publication Ref: R&D Technical Report P69

Development of PRAIRIE™ Dispersion Modelling

Hancox J and Clark J W (1997)

AEA Technology

Project No. P2-707

Commissioned Programme: Water Quality

This study formed part of Project P2-707 (see *Publication Ref: R&D Technical Report P68*). It evaluated a number of aspects associated with the physical modelling currently used in PRAIRIE™. It examined the advection-diffusion model, and identified improvements that could be made to deterministic and probabilistic modelling. It compared the ADZ (aggregated dead zone) model with PRAIRIE's ADE (advective dispersion equation) model and assessed how easily it might be incorporated into PRAIRIE™.

Possible improvements to PRAIRIE's deterministic and probabilistic calculations are identified and briefly discussed, and the results given of work on the ADE and ADZ models.

Other outputs from this project are:

R&D Technical Report P68: PRAIRIE™ Guidance

R&D Technical report P70: Updating of PRAIRIE™ DATABASES

Publication Ref: R&D Technical Report P70

Updating of PRAIRIE™ Databases

Clark J W (1997)

AEA Technology

Project No. P2-707

Commissioned Programme: Water Quality

This report summarises work to extend the PRAIRIE™ databases (see also *Publication Ref: R&D Technical Report P68*). The water quality database was revised and the chemical database extended from 89 to 250 entries. Suggested no adverse response levels for humans (SNARLs) were revised and included in the substances database.

The report concludes with recommendations for the PRAIRIE™ development group.

Other outputs from this project are:

R&D Technical Report P68: PRAIRIE™ Guidance

R&D Technical Report P69: Development of PRAIRIE™ Dispersion Modelling

Publication Ref: R&D Technical Report W77

Review of Natural Resource Plans and Development Programmes

Jones G, Andrews L and Bascombe A (1997)

Ove Arup and Partners

Project No. W4-641

Commissioned Programme: Local Government Liaison

The environment can be affected by the plans and programmes of central and local government and other agencies. These include statutory land-use plans (for example, structure plans), non-statutory plans (for example, Area of Outstanding Natural Beauty management plans) and specific investment programmes (for example, agri-environmental schemes, transport plans). By influencing these, the Agency can help to improve the environment for present and future generations, and the aim of this project is to ensure that staff are aware of the opportunities and mechanisms for doing so.

The report provides information on such plans and programmes and describes the benefits of Agency involvement. Advice is given on interpreting the information to identify priorities for action and to ensure that good practice facilitates the effective use of resources.

Publication Ref: R&D Technical Report W32

A Methodology for Community Involvement in LEAPs

Downs S E J (1997)

Baker Associates

Project No. W4-680

Commissioned Programme: Local Government Liaison

Local Environment Agency Plans (LEAPs) are a development of the Catchment Management Plans (CMPs) of the National Rivers Authority. Such planning is a relatively new concept, and a number of techniques have been used by the regions with varying success.

The objectives of this study were to:

- undertake case studies of CMPs to analyse their strengths and weaknesses;
- explore practice in a number of organisations with a similar need to involve the community;
- produce recommendations on how to involve external organisations more effectively in LEAPs.

The report recognises the need for a consistent objective for consultation, and recommends that potential consultees are categorised according to their propensity to be involved. There should be less effort to involve general consultees, and a greater focus on key groups.

The report suggests an approach to ensure that participation is seen as an ongoing process, and recommends closer links with other plans, such as business plans and “Local Agenda 21s”. It highlights the implications for the Agency’s resources and style of working should the recommendations be implemented.

3.5 Addressing Climate Change

3.5.1 The Issues

The balance of evidence now suggests that "greenhouse gas" emissions – such as carbon dioxide, methane and nitrous oxide, associated with human activities connected with transport, industrialisation and agriculture – are causing changes to global climate. Unless reductions in emissions are made, these changes will cause significant ecological and socio-economic impacts at regional and global levels. The risks and causes of climate change are such that the Agency must both plan for its consequences (adaptation) and act to reduce greenhouse gas emissions through its regulatory functions on industry (mitigation). R&D will help the Agency to assess the potential effects of climate change and to identify appropriate responses.

The assessment of potential climate change impacts depends on the application of climate models and scenarios. The effects of climate change on the UK are still difficult to predict. Those relevant to the Agency include sea level rise and related stresses on the coastal zone, change in geographical and seasonal distribution of rainfall, and changes in the severity and frequency of floods and storms, together with the effects of these changes on flora, fauna and environmental quality. The impact of climate change on regional economies will depend on human intervention and response. The Agency will work with the UK Climate Impacts Programme to understand these effects. There are serious implications for many of the Agency's functional responsibilities.

3.5.2 Under the Environmental Strategy, the Agency will:

- help to ensure that UK greenhouse gas emission reduction targets are met;
- develop methods to improve our estimates of methane emission from landfill sites;
- promote tax incentives to reduce energy production from fossil fuels;
- set an example by reducing the Agency's own energy and fossil fuel consumption;
- investigate the likely effects of climate change on the environment of England and Wales;
- investigate how best the Agency might respond to these effects;
- provide improved mapping of areas at risk from flooding due to climate change;
- develop techniques to identify changes in flora as an indicator of effects of climate change;
- contribute our knowledge and expertise to national and international forums on climate change.

3.5.3 Outputs

There are no outputs produced in 1997/98 that fall within the key environmental theme of Addressing Climate Change. Projects ongoing into 1998/99 are listed in Appendix 3.

3.6 Regulating Major Industries

3.6.1 The Issues

Industry is essential for the economy and high living standards of our society. Regulation is necessary, however, in order to prevent or minimise pollution so that industrial activity can continue without adversely affecting the environment and human health. Major industries will need to operate within the EC Directives on integrated pollution prevention and control, and the control of major accident hazards, as well as other national and international laws, protocols and obligations. These ensure that releases and discharges of potentially polluting substances to the environment are regulated and that strict levels are maintained on emissions.

Use of BATNEEC and BPEO aims to achieve pollution control that reconciles society's interest in the environment with industry in both the short and long term. The Agency needs R&D to support development of regulatory policy and assessment methods and techniques, particularly to provide a firm scientific and technical basis for its decisions, and to encourage the most cost-effective options for pollution prevention. This will increasingly involve clean and efficient technologies, and encourage industry to account to its customers for its environmental position.

3.6.2 Under the Environmental Strategy, the Agency will:

- continue the efficient and effective delivery of Integrated Pollution Control;
- implement the requirements of the EC Directive on IPPC;
- implement the relevant requirements of the Control of Major Accident Hazards Directive;
- develop practical working relationships with fellow regulators, particularly HSE;
- develop pollution prevention control tools;

- encourage the use by industry of BS 7750/ISO 14001 accreditation;
- encourage registration under EU ecomanagement and audit regulations;
- pay special attention to the needs of small and medium-sized enterprises;
- maintain and expand the Chemical Release Inventory;
- introduce operator and pollution risk appraisal (OPRA);
- ensure that radioactive releases from nuclear sites are well within accepted limits;
- develop toxicity-based consenting methods for complex industrial discharges;
- ensure improvements are made to the quality of discharges to estuarine and coastal waters;
- implement the requirements of the EC Urban Waste Water Treatment Directive;
- investigate means of mitigating environmental impact of disinfection/sterilisation techniques;
- develop tools to assess risks, costs, benefits and options for industrial stresses.

3.6.3 Outputs

This section lists the 12 outputs produced in 1997/98 that are most relevant to this key environmental theme, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those outputs available to the general public.

The principal outputs that fall within the environmental theme of Regulating Major Industries are:

Technical Report P97
The Nuclear Agency Database of Features Events and Processes – Application by the Environment Agency

Technical Report P95
Maintenance of HMIP/Environment Agency Assessment Toolkit

Technical Report P28
Toxicity Reduction Evaluation Case Summary for the Pulp and Paper Industry

Project Record P2/i493/11
Toxicity Reduction Evaluation Case Summary for the Pulp and Paper Industry

Technical Report P105
Control of Mercury and Cadmium in Liquid Discharges

Project Record P4/028/1
Control of Mercury and Cadmium in Liquid Discharges

Technical Summary PS187
Evaluation of BATNEEC/BPEO Cases in Applications for Authorisation of the Electricity Supply Industry

Technical Report P62
Exposure Commitment Approach to the Derivation of Environmental Assessment Levels: Feasibility Study

Technical Report P92
An Assessment of the Feasibility of Using DGT Procedures to Measure Trace Metals and Radionuclides in Rivers

ISBN 0-11-702010-9
Released Substances and their Dispersion in the Environment: Guidance for Applicants for Process Authorisation under Integrated Pollution Control

Technical Report P56
Environmental Protection Act 1990 – Best Practicable Environmental Option and Other Assessment Methods: Case Study Comparisons

Technical Report P61
Dioxin Markers Feasibility Study

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report P95

Maintenance of HMIP/Environment Agency Assessment Toolkit

Marrison A (1997)

Risk Management Consultants

Project No. CPR2/41/1/191

Commissioned Programme: Radioactive Substances

Risk Management Consultants (RMC) have more than 150 MicroVAX tapes, generated by subcontractors to the Agency and HMIP (an Agency predecessor) on behalf of the radioactive waste disposal assessment project. As the tapes become obsolete it is necessary to ensure that data remains accessible, so this project aimed to copy data from the tapes to DOS format on CD-ROMS.

The report gives details of the 112 tapes processed, and notes 12 where errors made processing impossible. The CD-ROMS are retained by RMC for use on current projects.

Publication Ref: R&D Technical Report P28

Toxicity Reduction Evaluation Case Summary for the Pulp and Paper Industry

Parsons Engineering Science (1996)

Project No. P2-493

Commissioned Programme: Water Quality

The Agency is developing a toxicity-based consent (TBC) programme to control discharges to UK waters. This report aims to help the pulp and paper industry to address the new toxicity criteria.

The study used information from toxicity reduction evaluation (TRE) studies in the US and Canada, focusing on the causes of toxicity that may be common to paper mill discharges.

The role of chemical additives in pulp and paper effluents can be readily determined through bench-scale testing using the US Environmental Protection Agency's toxicity identification evaluation (TIE) procedures. Other causes of toxicity, such as organic compounds, may be reduced through improvements in water management and biological treatment. Additional TRE examples are noted, based on experience in similar US industries.

Publication Ref: R&D Technical Report P105

Control of Mercury and Cadmium in Liquid Discharges

McCrea J *et al* (1997)

WS Atkins

Project No. P4-028

Commissioned Programme: Process Industries Regulation

This report contains the findings of research into methods for the control of mercury and cadmium from industries regulated under the Environmental Protection Act and the Water Industries Act.

The study aimed to:

- present the findings of a literature survey;
- identify and, where possible, quantify UK sources and releases;
- identify best available techniques for controlling these releases, including cost/benefit analysis;
- identify elimination, substitution or abatement techniques and the industries to which these are most applicable;
- identify and investigate areas of future concern.

It was found that the regulation of processors' releases to air, land and water has caused steep reductions in the pollution potential of industrial waste streams, with significant reductions in mercury and cadmium releases.

Delays in publishing the original report (March 1994) mean that statistics have been updated and significant developments included from the intervening years. Recommendations are made for further work to facilitate the application of Integrated Pollution Control.

Publication Ref: R&D Technical Report P62

Exposure Commitment Approach to the Derivation of Environmental Assessment Levels: Feasibility Study

Rowlinson P, Williams W P and Mahiout L (1997)

Monitoring and Assessment Research Centre

Project No. CPR2/41/1/119

Commissioned Programme: Process Industries Regulation

Exposure commitment is a method of assessing total lifetime human exposure to environmental contaminants and identifying key pathways to exposure. The project aimed to test the feasibility of this method for deriving consistent long-term environmental assessment levels (EALs).

The main objectives of the study were to:

- review the literature relating to exposure commitment/assessment, and its application to regulatory processes worldwide;
- collate environmental and toxicological data on a range of six contaminants and use it to determine current exposure in the general population;
- compare current exposure with maximum acceptable long-term exposure data from toxicological investigations, and derive maximum acceptable environmental levels;
- compare derived EALs with current environmental standards.

A consistent UK protocol was produced for estimating human exposure to environmental contaminants. EALs were calculated for five of the six contaminants, and the literature search found other substances which might be considered in the future.

The report suggests other possible uses of predictive models for estimating organic pollutants in the environment, and also outlines the limitations of the approach. The study concluded that exposure commitment could be a useful tool for determining environmental assessment levels that take account of the risks of long-term human exposure.

Publication Ref: R&D Technical Report P92

An Assessment of the Feasibility of Using DGT Procedures to Measure Trace Metals and Radionuclides in Rivers

Davison W and Hutchinson W (1997)

Environmental Sciences, Lancaster University

Project No. CPR2/41/1/131

Commissioned Programme: Process Industries Regulation

The sampling and analysis of waters for trace metals and radionuclides requires an *in situ* procedure providing a quantitative integrated record of well-defined solution species of trace metals and radionuclides. A simple chemical diagnostic for potential metal toxicity is needed for the development of quality standard and risk assessment protocols for the impacts of metals in contaminated waters. The procedure of diffusive gradients in thin-films (DGT) has recently been developed.

This study aimed to develop DGT into a practical device and to establish its feasibility for measuring several metals in freshwater. Particular emphasis was placed on verifying basic principles and establishing practical performance characteristics.

This report presents the details and findings of the study. It concludes that DGT is a cheap, reliable device that can be used to measure *in situ* labile species of trace metals and potentially radionuclides. Recommendations are made for further development and testing of the DGT device.

Publication Ref: ISBN 0-11-702010-9

Released Substances and their Dispersion in the Environment: Guidance for Applicants for Process Authorisation under Integrated Pollution Control

Environmental Analysis Co-operative (1997)

Project No. CPR2/41/1/139

Commissioned Programme: Process Industries Regulation

Under the Environmental Protection Act, 1990, industry applying for approval under IPC must provide data on chemicals released from processes and their dispersion in the environment. With the aim of producing guidance on this, a co-operative was formed of representatives from more than 50 industrial companies, government, environmental bodies and consultants.

This guidance is designed to help those applying for authorisation of their processes under IPC. It is written with an applicant in mind who does not have the extensive environmental advice often available in large companies. It is hoped, however, that it will be followed by all applicants, and thereby help to improve the quality and consistency of IPC applications. This should facilitate the inspection process, assist statutory consultees and help to reduce costs.

Publication Ref: R&D Technical Report P56

Environmental Protection Act 1990 – Best Practicable Environmental Option and Other Assessment Methods: Case Study Comparisons

Barry M K, Hunt D T E and Dobbs A J (1997)

WRc plc

Project No. CPR2/41/1/239

Commissioned Programme: Process Industries Regulation

The Environmental Protection Act 1990 outlines the objectives that must be met by the Agency when setting conditions in authorisations under IPC. It states that pollution should be minimised with regard to the best practicable environmental option (BPEO). As a means of identifying this, the Agency has developed the IPC BPEO methodology.

This study aimed to review:

- other environmental assessment methodologies, to identify elements that might augment the IPC BPEO methodology;
- recent case studies using the IPC BPEO methodology to identify areas where the Agency's guidance might be improved.

A number of environmental methodologies were reviewed, and found to have elements that might contribute to the IPC BPEO methodology. Useful information and potential modifications were identified in the case studies.

This report includes recommendations concerning the integration into the IPC BPEO methodology of concepts, practices and tools from other methodologies. Some of these require further research before implementation.

Publication Ref: R&D Technical Report P61

Dioxin Markers Feasibility Study

Environmental Resources Management (1997)

Project No. CPR2/41/1/256

Commissioned Programme: Process Industries Regulation

Dioxins are released in emissions from combustion and other thermal industrial processes and in the effluent from some chemical manufacturing processes. The release of dioxins is subject to strict regulatory control by the Agency, but the high cost and complexity of analysis restricts the frequency of monitoring.

This study aimed to:

- examine the feasibility of supplementing conventional analysis with immunoassay techniques;
- provide information to encourage the commercial development of dioxin measurement kits.

The work considered emissions from municipal and chemical waste incinerators and iron and steel production, and effluent from the manufacture of vinyl chloride monomer. The details and findings are contained in this report.

The study recommends the development and field validation of simplified sample preparation and sample clean-up procedures, along with an adequate quality assurance system.

3.7 Improving Air Quality

3.7.1 The Issues

Air quality is affected by emissions from industrial processes and urban development, particularly from transport. Air pollution is perceived by the public as a major environmental issue due to its effects on human health. It therefore needs to be monitored and reduced in order to provide a better quality of life, and to protect the environment from effects such as acid rain, which damages buildings and vegetation.

Although the Agency only has regulatory responsibilities for Part A IPC processes, it must advise local authorities of the impacts of these processes in their areas, and form an opinion on the state of pollution of the environment. In order to do this, the Agency will compile relevant information and report on the specific actions it is taking relative to other sources of emissions. R&D will support both the assessment and reporting of the issues, and the development of responses to control air pollution and improve air quality. The Agency's response could reduce emissions to the atmosphere from IPC processes, greenhouse gases (see "Addressing Climate Change"), acid rain and landfill gas.

The Government's national air quality (NAQ) strategy sets out objectives to be achieved by the year 2005, and will be reviewed in 1998. The Agency needs to consider its role in this.

3.7.2 Under the Environmental Strategy, the Agency will:

- help the Government to deliver its national air quality strategy;
- ensure that emissions to the atmosphere from major industrial processes are reduced;
- ensure that specific emissions of $S0_2$ and N0x, which contribute to acid rain, are reduced;
- discourage the use of solvents in industry, which contribute to ozone production;
- set an example in reducing overall emissions from the Agency's vehicles.

3.7.3 Outputs

There are no outputs produced in 1997/98 that fall within the key environmental theme of Improving Air Quality. Projects ongoing into 1998/99 are listed in Appendix 3.

3.8 Managing Waste

3.8.1 The Issues

Many different varieties of waste, including radioactive, enter our environment. We need R&D to know exactly what is produced, its pathways and destination, and how best it can be controlled and managed. The national waste strategy and the new EC Directives on IPPC and landfill set the policy framework within which effective waste management will be developed. Waste minimisation is increasingly recognised by many companies as vital to the profitability of their business. Increased waste reduction, and recovery and recycling of waste, is to be encouraged wherever possible, with a long-term reduction in disposal to landfill. Life-cycle assessment and risk management are important concepts in identifying best environmental options.

Effective radioactive waste disposal is needed to protect humans and the environment in the present and long term. There is a growing need to combat illegal trading in waste at national and international levels.

3.8.2 Under the Environmental Strategy, the Agency will:

- develop an overall database of waste arisings and disposals;
- measure effectiveness of taxation to reduce waste and encourage its re-use/recycling;
- obtain information on flytipping and devise means of combating it;
- develop life-cycle assessment methodologies for dealing with waste;
- encourage industry to develop techniques for managing special/other industrial wastes;
- achieve national waste strategy targets for reduction of waste disposal to landfill;
- achieve national targets for the recovery, recycling and composting of municipal waste;
- combat organised crime in illegal trade of waste both nationally and internationally;
- investigate the technical needs of successful waste management, including BPEO;
- secure high-quality management of radioactive waste in industry;
- ensure that disposal of solid radioactive waste safeguards humans and the environment;

- investigate the potential effects of any wastes entering the environment.

3.8.3 Outputs

This section lists the nine outputs produced in 1997/98 that are most relevant to this key environmental theme, though they may also have a connection to other frameworks and/or themes. Summary information is provided for those outputs available to the general public.

The principal outputs that fall within the environmental theme of Managing Waste are:

Technical Report P171 (CWM 035A/94)
The Technical Aspects of Controlled Waste Management: Laboratory Studies of Landfill Leachate-Triassic Sandstone Interactions

Technical Report P174 (CWM 142/96A)
Guidance on the Emissions from Different Types of Landfill Gas Flares

Project Record PP035
Guidance on the Emissions from Different Types of Landfill Gas Flares

Technical Report P173 (CWM 121/95)
Development of PCR Techniques and DNA Probes for Detection, Enumeration and Identification of Methanogens in Landfills

Project Record PP020
Development of PCR Techniques and DNA Probes for Detection, Enumeration and Identification of Methanogens in Landfills

Technical Report P177 (CWM 158/96)
Field Trials of Compost for Agriculture

Technical Report P93
3D Colloid Migration in a Non-Uniform Slot Fracture

Technical Report P50
The Removal of Technetium from EARP Waste Streams, Phase II

Technical Report P55
The Removal of Technetium from EARP Waste Streams, Phase III

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report P171 (CWM 035A/94)

The Technical Aspects of Controlled Waste Management: Laboratory Studies of Landfill Leachate-Triassic Sandstone Interactions

Thornton S F, Lerner D N and Tellam J H (1995)

School of Earth Sciences, University of Birmingham
Department of Civil and Environmental Engineering, University of Bradford

Project No. P1-203

Commissioned Programme: Waste Regulation and Management

Under the DETR's controlled waste management programme, a number of landfills on major UK aquifers have been investigated to obtain data for use in developing guidelines on waste disposal practice.

This report describes a laboratory study of leachate/rock interactions at the Burntstump landfill site, Nottinghamshire.

The aims of the study were:

- to determine whether the chemical variations observed in the field can be replicated in the laboratory; if so
- to interpret the more comprehensive laboratory data as a guide to what happens in the field;
- to carry out and interpret laboratory experiments to indicate the effects of likely future changes in landfill leachate chemistry.

The results of such work might provide a means of predicting leachate/aquifer interactions in the long term.

This report contains details of the study, its results and preliminary quantitative interpretations.

Publication Ref: R&D Technical Report P174 (CWM 142/96A)

Guidance on the Emissions from Different Types of Landfill Gas Flares

Frost R C, Pearson J E and Sykes J (1997)

AEA Technology

Project No. P1-218

Commissioned Programme: Waste Regulation and Management

Waste Management Paper 27 (WMP 27) advises that landfill gas should be controlled either by collection and burning in flares or by an energy recovery plant. The purpose of flaring is to dispose safely of the flammable constituents and to control odour nuisance, health risks and adverse environmental impacts. Consideration is needed, however, of the environmental impact and possible health risks associated with the combustion products of flaring. WMP offers minimal advice on flare operating conditions.

This study aimed to provide more guidance on landfill gas flaring. It reviewed and evaluated technologies and techniques for measuring and controlling emissions, and conducted a review of relevant literature.

The report recommends best practice for setting up, operating and monitoring landfill gas flare systems, and describes operating and emissions standards currently in place.

Publication Ref: R&D Technical Report P173 (CWM 121/95)

Development of PCR Techniques and DNA Probes for Detection, Enumeration and Identification of Methanogens in Landfills

Luton P E, Riley P W and Sharp R J (1995)

Centre for Applied and Microbiological Research

Project No. P1-228

Commissioned Programme: Waste Regulation and Management

The aim of this work was to develop improved methods using molecular techniques for studying the microbiology of landfill. The polymerase chain reaction (PCR) is a highly sensitive technique. It can detect and amplify very small amounts of the genetic material DNA to levels where further analysis will yield a great deal of information. The reaction can also be designed to be selective, amplifying DNA from individual species or groups of species.

This study used the PCR technique to detect and identify methane-producing micro-organisms in samples of landfill. It devised a technique (still to be fully developed) for measuring the number of methanogens present in laboratory samples, and developed an extraction protocol to enable the purification of DNA from samples of landfill material and leachate.

These techniques will lead to improved understanding of the microbiology of landfill and better monitoring of waste degradation.

Publication Ref: R&D Technical Report P177 (CWM 158/96)

Field Trials of Compost for Agriculture

Wallace P A (1996)

Levington Agriculture Ltd

Project No. P1-235

Commissioned Programme: Waste Regulation and Management

This project aimed to:

- assess the performance of composts produced by other research projects for their use as soil improvers and growing media;
- assess the benefit of the use of waste-derived compost on the growth of oilseed rape as an example of agricultural practice.

This report details field trials of compost use on an agricultural crop of oilseed rape. Two soil types were tested at application rates of up to 100 t/ha.

The study found that early plant establishment was improved. Early advantages were lost, however, because of competition between plants at the planting density used. Overall yield was unaffected by compost use. The report concludes that the benefits of compost would be most pronounced in poor years, when conditions limit germination and water supply. Estimates are provided of the value of the compost to agricultural users.

Publication Ref: R&D Technical Report P93

3D Colloid Migration in a Non-Uniform Slot Fracture

Lee A J and Grindrod P (1997)

QuantiSci Ltd

Project No. CPR2/41/1/208

Commissioned Programme: Radioactive Substances

The role of colloids in the transport of radionuclides through the geosphere is recognised as an important factor in assessing the long-term performance of underground radioactive waste disposal facilities. Laboratory studies have demonstrated that the presence of colloids can lead to enhanced mobility of radionuclides such as thorium. Most of the studies have been based on packed columns or migration in porous media such as sandstone, with little work studying or modelling the mobility of colloids in fractured rock.

This study examined the modelling of colloid migration through a synthetic fracture under closely controlled laboratory conditions. A prototype 3-D particle tracking code (LAGRANGE-3D) was applied to simulate colloid migration through a simple fracture, and the code extended to enable variable fracture aperture calculations.

This report gives details of the work, with suggestions for its further development.

Publication Ref: R&D Technical Report P50

The Removal of Technetium from EARP Waste Streams, Phase II

Fletcher P A *et al* (1996)

AEA Technology

Project No. CPR2/40/2/4

Commissioned Programme: Radioactive Substances

The first phase of this programme (Report No DoE/HMIP/RR/92.053) investigated methods of removing Technetium-99 (^{99}Tc) from the enhanced actinide removal plant (EARP) at Sellafield. It identified as a potential technique direct electrochemical reduction of the pertechnetate anion to insoluble technetium dioxide.

This report details the second phase of the programme, which investigated the interferences posed by certain other species. It found that in the presence of other oxidising agents (such as ruthenium) an induction period occurred prior to the technetium removal. It also established that the technetium-bearing coating slowly corroded, although this was prevented in the short term by the use of cathodic protection.

R&D Technical Report P55: The Removal of Technetium from EARP Waste Streams, Phase III is an associated output from this project.

Publication Ref: R&D Technical Report P55

The Removal of Technetium from EARP Waste Streams, Phase III

Griffiths P G, Jones C P and Junkison A R (1996)

AEA Technology

Project No. CPR2/41/1/201

Commissioned Programme: Radioactive Substances

The first phase of this programme investigated methods of removing Technetium-99 (^{99}Tc) from the EARP at Sellafield. It identified as a potential technique direct electrochemical reduction of the pertechnetate anion to insoluble technetium dioxide. The second phase *(R&D Technical Report P50)* investigated the interferences posed by other species, and established that the technetium-bearing coating slowly corroded, although this was prevented in the short term by the use of cathodic protection.

This report contains details of the third phase, which compared several cathode materials and found that the best decontamination kinetics were provided by platinised titanium and carbon cathodes. It confirmed that the cathodic protection route almost completely inhibited the release of technetium from an electrodeposit over a period in excess of 1,000 hours.

A Porocell flow cell was commissioned and operated with manganese in the form of permanganate as an inactive simulant for technetium. It was extremely effective at removing manganese from the solution, although certain limitations were found.

Further work is under way to determine if the Porocell technique can be developed to a viable plant scale stage.

3.9 Managing Our Water Resources

3.9.1 The Issues

Water is a vital resource which must be used properly to avoid deterioration in quality and quantity. Our rivers and lakes support a huge variety of natural flora and fauna communities, and are an important recreational facility. There are a range of stresses acting on the water environment: recent droughts have resulted in dry river beds and depleted groundwater levels; demand from consumers is increasing; excessive nutrients in water from sewage and diffuse fertiliser inputs have caused eutrophication of surface waters; and groundwater is under stress from industrial and agricultural activities. Public attitudes to water conservation are also changing.

In response to these stresses, the Agency is developing a sustainable approach to water resources management, taking into account environmental, economic and social factors. R&D will help to assess the issues and to deliver sustainable solutions. These will involve resolving competing uses of the environment, making efficient use of existing resources (including changes in legislation and charges) and demand management, and planning for the effects of climate change.

3.9.2 Under the Environmental Strategy, the Agency will:

- demand more efficient use of water by industry and water companies;
- encourage better conservation and more efficient use of water by the public;
- promote the development and sale of low-water-usage domestic appliances;
- demand reductions in leakage by water companies prior to new resource exploitation;
- consider the imposition of selective metering where water supplies are under stress;
- encourage acceptance of metering when linked to other water-saving incentives;
- apply the Agency's groundwater protection policy to improve our groundwaters;
- carefully assess proposals for water transfer schemes to ensure no environmental damage;
- refuse exploitation of new resources unless water conservation has been introduced;
- implement quickly the current programme of alleviating low-flow rivers;
- seek new legislative powers to reform use of abstraction "licences of right";
- promote inter-basin transfer of water where the scientific basis to do so is sound;
- promote full planning consideration of the resource implications of new developments;
- support the UK position in the development of the EC Water Framework Directive;
- ensure that all environmental needs are considered in asset management plan negotiations;
- investigate more efficient methods for the management of water;
- investigate the potential risks for the aquatic environment arising from its mis-management.

3.9.3 Outputs

This section lists the 29 outputs produced in 1997/98 that are most relevant to this key environmental theme, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those outputs available to the general public.

The principal outputs that fall within the environmental theme of Managing Our Water Resources are:

Technical Report P96
Detailed Audit Protocol for Laboratories that Self Monitor under UWWTD

Technical Report P136 (FR/CL 0007)
National Consent Translation Project (NCTP) Phase II

Technical Report P2
Groundwater Pollution Research Reviews

Technical Report W72
Appraisal of the Use of Ecological Information in the Management of Low Flows in Rivers

Project Record W6/015/1
Appraisal of the Use of Ecological Information in the Management of Low Flows in Rivers

Technical Report W116
Evaluating the Impact of Restrictions on Customer Demand: Main Report

Technical Report W48
Ecologically Acceptable Flows, Phase II: Determination of Ecologically Acceptable Flows in Rivers with Seasonal Changes in the Density of Macrophytes

Technical Report W28
The Hydrogeological Classification of Superficial Clay: Hydrogeological Characterisation of Glacial Till in East Anglia

Technical Report W29
The Hydrogeological Classification of Superficial Clay: Hydrogeological Characterisation of Glacial Till and Glacio-Lacustrine Sediments in Shropshire

Technical Report W30
The Hydrogeological Behaviour of the Clay-with-Flints of Southern England

Technical Report W31
The Hydrogeological Classification of Superficial Clay: Methodology of Map Production

Project Records 455/01/NW, 455/02A/NW to 455/02F/NW, 455/03A/NW to 455/03C/NW, 455/04/NW
The Hydrogeological Classification of Superficial Clays

Technical Report W9
Groundwater Resource Reliable Yield – User Manual

Project Record W6/i544/7
Groundwater Resource Reliable Yield – User Manual

Technical Report W10
Key Components in Methodology Formulation

Publication No. 5
Broadleaf Woodlands: The Implications for Water Quantity and Quality

Technical Report W84
Abstraction Metering – Good Practice Manual

Technical Report W71
The Evaluation of Acoustic Doppler Current Profiler Equipment

Project Record W6/i705/1
The Evaluation of Acoustic Doppler Current Profiler Equipment

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report P136 (FR/CL 0007)

National Consent Translation Project (NCTP) Phase II

Foundation for Water Research (1998)

Project No. P2-049

Commissioned Programme: Water Quality

The National Consent Translation Project (NCTP) was established in response to industry concerns over the compliance implications of the Urban Waste Water Treatment Directive (UWWTD). Phase I of the project aimed to establish reliable estimates of the relationships between spot-based and composite-based effluent quality for certain determinands. A number of recommendations were made.

NCTP Phase II aimed to:

- examine the factors affecting percentage reductions during treatment;
- establish whether between-determinand correlations can be used to explain variations between sewage treatment works (STWs);
- investigate upper tier limits.

Models developed to investigate percentage removal found parameters accounting for much of the between-works variation. Works-specific relationships between chemical oxygen demand (COD) and biochemical oxygen demand (BOD) effluent quality were estimated for 42 STWs, and strong associations found for the majority. The search for factors explaining the variations in BOD and COD slopes was less successful.

The study's findings are detailed in this report. It concludes that marginal STWs will tend to find it easier to achieve compliance with the BOD effluent limit than with the COD limit.

The report also gives findings from a review of the outliers identified in NCTP Phase I, and discusses the compliance implications of upper-tier definition.

Publication Ref: R&D Technical Report P2

Groundwater Pollution Research Reviews

Briffett A *et al* (1996)

Geraghty & Miller International, Inc

Project No. P2-623

Commissioned Programme: Water Quality

A significant amount of UK research on groundwater pollution is funded by other agencies, and there is a need to improve dissemination of this information to Agency staff. This project therefore aimed to review recent research and compile a summary document.

Information was gathered from published lists, open literature and questionnaires sent to research institutions.

This document collates and summarises information on a selection of key groundwater pollution issues. Additional references are given with, where appropriate, listings of further research projects.

Other outputs from this project are:

R&D Technical Report P3: Bioremediation Technology Research

R&D Technical Report P4: Products Enhancing Biodegradation of Hydrocarbons

Publication Ref: R&D Technical Report W116

Evaluating the Impact of Restrictions on Customer Demand: Main Report

Fenn C R and Kemlo A J (1998)

UK Water Industry Research Ltd

Project No. W6-027

Commissioned Programme: Water Resources

The aim of this project was to develop a method for evaluating the impact of restrictions during droughts on customer demand for water. Such impacts are highly situation-specific and few reliable data exist. Data-analytical approaches can provide good estimates, but have high costs in terms of data acquisition, model development and management time and skill.

A method was developed based on estimation of the volume of water used by individual "micro-components" under restricted and unrestricted conditions. Acceptance testing showed the method to be sufficiently accurate, flexible and easily used to suit all sections of the industry.

This report defines the principles and procedures of the method. It provides calculation utilities and guidelines for application.

A separate document provides a software user guide and input data guidelines.

Publication Ref: R&D Technical Report W48

Ecologically Acceptable Flows, Phase II: Determination of Ecologically Acceptable Flows in Rivers with Seasonal Changes in the Density of Macrophytes

Hearne J, Johnson I and Armitage P (1996)

Institute of Hydrology

Project No. W6-282

Commissioned Programme: Water Resources

The Instream Flow Incremental Methodology (IFIM) is a procedure applied to rivers to determine the relationship between discharge and the physical habitat area available to aquatic species. PHABSIM (Physical Habitat Simulation) is a software package used to perform the calculations required for the IFIM procedure.

This study used published data on instream macrophyte growth in chalk streams to test the seasonal effects of plant growth on a hypothetical channel. The results show how these effects can significantly distort PHABSIM results.

An algorithm is proposed for use with PHABSIM which allows the effects of changes in macrophyte biomass to be included.

Publication Ref: R&D Technical Report W28

The Hydrogeological Classification of Superficial Clay: Hydrogeological Characterisation of Glacial Till in East Anglia

Klinck B A *et al* (1997)

British Geological Survey

Project No. W6-455

Commissioned Programme: Water Resources

The quantification of recharge to major aquifers through superficial drift is a principal concern when estimating groundwater resources and evaluating their protection from pollutants.

This study identified methodologies that can be combined to provide a classification scheme for superficial clay deposits. It focuses on the properties of lodgement tills, which form the dominant lithology of glacial deposits in the UK. Developing new methods for investigating the role of these deposits in groundwater resource estimation and protection relies on understanding major controls on groundwater flow through tills. These include physical properties such as grain size, fissuring and consolidation, as well as the geochemical and mineralogical properties that retard the migration of solids.

This report contains the results from laboratory and field studies conducted on glacial tills in East Anglia. A key criterion for selection of the study site was that it had drift contact with an underlying class A aquifer.

Other outputs from this project include:

Technical Report W29: The Hydrogeological Characterisation of Glacial Till and Glacio-Lacustrine Sediments in Shropshire

Technical Report W30: The Hydrogeological Behaviour of the Clay-with-Flints of Southern England

Technical Report W31: Methodology of Map Production

Publication Ref: R&D Technical Report W29

The Hydrogeological Classification of Superficial Clay: Hydrogeological Characterisation of Glacial Till and Glacio-Lacustrine Sediments in Shropshire

Wealthall G P *et al* (1997)

British Geological Survey

Project No. W6-455

Commissioned Programme: Water Resources

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This report contains the results from laboratory and field studies conducted on glacial tills in Shropshire. A key criterion for selection of the study site was that it had drift contact with an underlying class A aquifer.

Other outputs from this project include:

Technical Report W28: The Hydrogeological Characterisation of Glacial Till in East Anglia

Technical Report W30: The Hydrogeological Behaviour of the Clay-with-Flints of Southern England

Technical Report W31: Methodology of Map Production

Publication Ref: R&D Technical Report W30

The Hydrogeological Behaviour of the Clay-with-Flints of Southern England

Klinck B A *et al* (1998)

British Geological Survey

Project No. W6-455

Commissioned Programme: Water Resources

The quantification of recharge to major aquifers through superficial drift is a principal concern when estimating groundwater resources and evaluating their protection from pollutants.

This study identified methodologies that can be combined to provide a classification scheme for superficial clay deposits. It focuses on the properties of lodgement tills, which form the dominant lithology of glacial deposits in the UK. Developing new methods for investigating the role of these deposits in groundwater resource estimation and protection relies on understanding major controls on groundwater flow through tills. These include physical properties such as grain size, fissuring and consolidation, as well as the geochemical and mineralogical properties that retard the migration of solids.

This report also forms part of the British Geological Survey monograph series. It reviews the hydrogeological role of clay with flints and evaluates the significance of the deposits to groundwater resource management. A key criterion for selection of the study site was that it had drift contact with an underlying class A aquifer.

Other outputs from this project include:

Technical Report W28: The Hydrogeological Characterisation of Glacial Till in East Anglia

Technical Report W29: The Hydrogeological Characterisation of Glacial Till and Glacio-Lacustrine Sediments in Shropshire

Technical Report W31: Methodology of Map Production

Publication Ref: R&D Technical Report W31

The Hydrogeological Classification of Superficial Clay: Methodology of Map Production

Boland M P (1997)

British Geological Survey

Project No. W6-455

Commissioned Programme: Water Resources

The quantification of recharge to major aquifers through superficial drift is a principal concern when estimating groundwater resources and evaluating their protection from pollutants.

This study identified methodologies that can be combined to provide a classification scheme for superficial clay deposits. *Technical Reports W28 and W29* contain the results from laboratory and field studies conducted on glacial tills in East Anglia and Shropshire.

This report presents a methodology for displaying the information, based on existing hydrogeological maps. These could provide a valuable tool for those involved in interpreting the aquifer protection provided by superficial clay deposits. The main component of each map is a 1:50,000 contour map of clay thickness. If produced as transparent overlays, these maps can be used with solid and drift geology maps.

Other outputs from this project include:

Technical Report W28: The Hydrogeological Characterisation of Glacial Till in East Anglia

Technical Report W29: The Hydrogeological Characterisation of Glacial Till and Glacio-Lacustrine Sediments in Shropshire

Technical Report W30: The Hydrogeological Behaviour of the Clay-with-Flints of Southern England

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Publication Ref: R&D Technical Report W9

Groundwater Resource Reliable Yield – User Manual

Papaioannou A and Erskine A D (1997)

Entec

Project No. W6-544

Commissioned Programme: Water Resources

Agency policy states that groundwater should be managed as a sustainable resource, with the quantities of water authorised for abstraction balanced against the assessed environmental needs of rivers. Exceeding the yield of an aquifer is unsustainable and can have significant local and strategic effects on the environment. The Agency recognised the need to establish a national standard for estimating groundwater yield.

This project aimed to develop a methodology for estimating the groundwater resource reliable yield ("yield") of major aquifers. This was to be used on a national basis to improve water resource planning and aquifer management, and to provide a uniform approach to strategic assessments.

The resulting methodology provides a means of yield assessment that is widely applicable. It draws on the experience of past regional water authorities and best practice overseas, and incorporates new concepts with due consideration to abstraction licensing policy and practice. It aims to establish the proportion of average annual groundwater recharge that can be safely allocated to abstraction development, taking into account natural variations in recharge distribution, aquifer characteristics and environmental factors.

This document describes the formulation and use of the methodology. It recommends ongoing review and a programme of calibration and sensitivity testing to refine the methodology and its future application.

Technical Report W10: Key Components in Methodology Formulation is an associated ouput.

Publication Ref: R&D Technical Report W10

Key Components in Methodology Formulation

Papaioannou A and Erskine A D (1997)

Entec

Project No. W6-544

Commissioned Programme: Water Resources

Agency policy states that groundwater should be managed as a sustainable resource, with the quantities of water authorised for abstraction balanced against the assessed environmental needs of rivers. Exceeding the yield of an aquifer is unsustainable and can have significant local and strategic effects on the environment. The Agency recognised the need to establish a national standard for estimating groundwater yield.

This report complements *Technical Report W9: Groundwater Resource Reliable Yield – User Manual*, which describes the formulation and application of the groundwater resource reliable yield ("yield") methodology.

This document provides details of the groundwater modelling and analytical work that underpins the methodology. These relate to an idealised aquifer configuration, and the main focus demonstrates how the baseflow regime can be defined by a relatively simple aquifer recharge and typical aquifer characteristics.

Publication Ref: R&D Publication No. 5

Broadleaf Woodlands: The Implications for Water Quantity and Quality

Kirby C *et al* (1998)

Institute of Hydrology

Project No. W6-628

Commissioned Programme: Water Resources

Since the end of the First World War re-afforestation in the UK has progressed steadily, and timber production will double over the next 20 years. Concerns about wildlife, aesthetics and the need for "natural" forest mean that more broadleaved trees than conifers are now planted.

Recent pressure on water supplies has raised questions about the amount of water consumed by actively growing trees. This has been extensively researched on upland conifer plantations, but its significance for other tree types has been assessed only recently. The Agency, the Natural Environment Research Council and the DETR funded research into the important water management issues for lowland woodlands.

This report reviews the likely place of broadleaved woodland in future land-use policy, and gives an overview of present resources. Key physiological processes of trees and their relationship to hydrological and hydrochemical aspects of water resources are addressed in detail, supported by the results of case studies of research plots on different soil types. The report identifies the implications for water use and quality and suggests the likely effects of climate change.

Publication Ref: R&D Technical Report W84

Abstraction Metering – Good Practice Manual

Godley A (1997)

WRc plc

Project No. W6-659

Commissioned Programme: Water Resources

The principal reason for measuring the quantity of water abstracted is to allow the Agency to manage the nation's water resources. Those needing to take water apply to the Agency for a licence to abstract. The licence imposes conditions regarding the quantity of water allowed.

This manual covers the measurement in closed conduits of water abstracted under licences administered by the Agency. It aims to:

- provide guidelines on abstraction measurement common to all Agency regions;
- instruct Agency licensing and enforcement staff on good practice for metering water abstraction;
- provide a reference work for abstractors, manufacturers, fabricators, installers and contractors;
- recommend appropriate accuracy standards for all types of abstraction measurement;
- improve the standard of accuracy of abstraction measurement.

The manual has been compiled using data from Agency documents, British Standards, site visits, technical books and papers. Consultations were held with abstractors, equipment manufacturers, trading standards and Agency staff.

Publication Ref: R&D Technical Report W71

The Evaluation of Acoustic Doppler Current Profiler Equipment

Child S C *et al* (1997)

Hydro-Logic Ltd

Project No. W6-705

Commissioned Programme: Water Resources

The Acoustic doppler current profiler (ADCP) technique, originally used for oceanographic research, was recently developed for use in coastal areas, estuaries and rivers. This report contains the findings of a project undertaking a full field evaluation of the device in the fluvial environment.

Field visits were made to 21 sites, and trials carried out at gauging stations to allow comparison of ADCP measured flows with known data. Evaluation was made of the instrument's performance in a variety of physical conditions and channel characteristics, and of the accuracy and repeatability of measurements. Cost benefits were examined, as were logistical requirements such as different deployment methods, manning levels and time. A literature and user review was also performed.

The operational limits of the ADCP were established, and initial logistical and measurement problems identified. Under the resulting working practice the ADCP generally performed well, proving suitable for use under many of the conditions encountered in UK rivers.

3.10 Delivering Integrated River-Basin Management

3.10.1 The Issues

Individual river basins require different management depending upon the source, quantity and quality of the water flowing within them, and the needs and influences of the local environment, community and industries. River basin management is planned by the Agency in partnership with other interest groups via LEAPs. These address local stress points and help to ensure that all waters are of sustainable quality for their different uses. LEAPs must address the competing needs of industry and social and environmental concerns.

R&D helps the Agency to assess the quality of the environment and resolve the stresses on it, to weigh up costs and benefits, to prioritise actions, and to take account of public opinion. Flood defence is a key area of Agency responsibility within river-basin management. We need to be able to define where it is safe to build, which land and life forms need protection, and how this might be achieved. This holistic approach to environmental planning has links with other key themes – Water Resources, Climate Change and Biodiversity.

3.10.2 Under the Environmental Strategy, the Agency will:

- manage river basins in an integrated way, via LEAPs;
- ensure that all waters are of sustainable quality for their different uses;
- deliver a continual improvement in overall water quality;
- provide effective flood defence, and an effective flood warning system;
- increase the number of rivers and still waters able to support viable fisheries;
- enhance and conserve inland navigation as all-round national assets;
- secure the best operational framework to ensure sustainability of our navigational waters;
- work with others to improve and develop inland waterways as an integrated network;
- improve river habitat quality, as measured by river habitat surveys;
- improve wetland management;
- improve riverside landscapes;
- improve bathing water quality;
- improve estuarine waters for shellfisheries;
- increase the number of Agency sites available for public recreation;
- work with local authorities to maximise conservation and recreational potential of river-basins.

3.10.3 Outputs

This section lists the 31 outputs produced in 1997/98 that are most relevant to this key environmental theme, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those outputs available to the general public.

The principal outputs that fall within the environmental theme of Delivering Integrated River-Basin Management are:

Technical Report P78
Sustainable Systems of Outdoor Pig Production

Technical Report P72
Benthic Algal Mats in River Systems

Technical Report P113
Alternative Farming Methods (Arable – Phase 2)

Technical Report P206
Farm Effluent Treatment: an Innovative Approach

Note 393
The Implementation of the Urban Wastewater Treatment and Nitrates Directive

Technical Report P104
Colour Standards for Watercourses

Project Record P2/i275/1
Colour Standards for Watercourses

Technical Report P14
Biogeochemical Controls on Phosphorus Cycling between Sediment and Water in Estuaries

Project Record P2/i436/1
Removal of Colour from Industrial Dyehouse Effluent Using Biosorption

Technical Report P175 (CIRIA Report 167)
Use of Industrial By-Products in Road Construction – Water Quality Effects

Technical Report P3
Bioremediation Technology Research

Technical Report P4
Products Enhancing Biodegradation of Hydrocarbons

Technical Report P176
Building a Cleaner Future – Construction Site Pollution Prevention

Technical Report P19
Review of the Use of Chlorine for Sewage Disinfection

Technical Report P47
Evaluation of Blue-Green Algal Blooms

Project Record W1/003/1
Nutrient Management in Rivers

Publication 2 (CIRIA Report 180)
Review of the Design and Management of Constructed Wetlands

Technical Report W76
Private Boating Price-Demand Relationship

Project Record W3/002/1
Private Boating Price-Demand Relationship

Project Record W3/i692/1
The Safe Use of Instream Structures – Response to Questionnaire Survey

Technical Report W53
Economic Benefits of Flood Warning and Forecasting

Technical Report W109
Fluvial Design Guide

Technical Report W85
Water Level Management Plans – Scoping Study

Technical Report W88
Benchmarking and Scoping Study of Hydraulic River Models – Stage Two: Final Report

Report 31 (CIRIA Report 157)
Guidance on the Disposal of Dredged Material to Land

Technical Report W16 (CIRIA Ref: FR/CP/40)
Hydraulic Design of Culverts

Technical Report W38
Guidance on Development in Areas at Risk from Tidal Flooding

Technical Report W41
Earth Embankment Fissuring Manual

Project Record W5/172/3
Earth Embankment Fissuring Manual

Technical Report W105
Biological Control of Weeds – A Scoping Study of the Feasibility of Biological Control of Aquatic and Riparian Weeds in the UK

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report P78

Sustainable Systems of Outdoor Pig Production

Danks P and Worthington T (1997)

CAMBAC JMA Research and Reading Agricultural Consultants

Project No. P2-001

Commissioned Programme: Water Quality

Little is known of the incidence and nature of pollution from land stocked with outdoor pigs, or the potential polluting effects of run-off from such land. This project was initiated to investigate some of these effects, and complements a parallel MAFF-funded study.

A survey related individual outdoor pig units to soil type, proximity to watercourses and other water features, land drainage, slope, erosion risk and rainfall. Characteristics identified were stocking rate and type, tenure, vegetation and previous crop. Risk scores were estimated for six factors and accumulated to provide an overall assessment of risk from the sample sites.

The main risk factors identified for any outdoor pig site are its proximity to surface waters and/or the presence of an underlying aquifer. The report suggests measures to reduce pollution risk and recommends the construction of a model to assess the risk of pollution from proposed outdoor pig sites.

Publication Ref: R&D Technical Report P72

Benthic Algal Mats in River Systems

Bowburn Consultancy (1997)

Project No. P2-030

Commissioned Programme: Water Quality

Floating algal mats are frequently reported in UK rivers between March and November. Most consist predominantly of diatoms, but some are of blue-green algae, and there is concern about the potential of these to cause illness to river users.

This research aimed to investigate occurrences of algal mats in the Agency regions and to examine how risks were assessed.

The study confirmed 16 reports of blue-green algal mats in five Agency regions in 1996. Animal illness and rashes on humans were reported in two regions. Differences were found in the way that regions decided whether mats represented a risk and then managed incidents once blue-green algae were confirmed.

A procedure is recommended for the future management of these incidents. Such an approach, in conjunction with record-keeping and auditing of key stages, should allow a clearer picture to emerge of the distribution of these incidents.

Publication Ref: R&D Technical Report P113

Alternative Farming Methods (Arable – Phase 2)

Jordan V W L and Hutcheon J A (1997)

Institute of Arable Crop Research, Long Ashton

Project No. P2-047

Commissioned Programme: Water Quality

This report covers the second phase of a project investigating the impact of conventional and arable crop production systems on herbicide and nutrient emissions and water pollution from diffuse sources.

Experimental plots and two demonstration farms were used in the study. The quality of drainage water from fields cultivated with an integrated farming system (IFS) was compared with that from another part of the same farm using standard farming practice (SFP). Monitoring was for selected pesticides used in both systems, nitrate and phosphate.

The findings confirm many of those in the initial report (Project No. 542 *R&D Technical Report P17*). The IFS required significantly lower doses of herbicides, pesticides and fungicides, and produced smaller quantities in drain water. IFS plots showed consistently lower losses of nitrate and phosphate, and their improved soil structure and surface stability resulted in lower drainflow. The reduced variable costs of the IFS allowed gross margins to be maintained.

The report recommends that the adoption of IFS is encouraged as a means of providing more environmentally sustainable farming. Suggestions are given as to how this might be achieved.

Publication Ref: R&D Technical Report P104

Colour Standards for Watercourses

Brown P J *et al* (1998)

University of Leeds
WRc plc

Project No. P2-275

Commissioned Programme: Water Quality

Public awareness of environmental issues has led to an increased number of complaints about coloured discharges to rivers from dyeworks and the textiles industry. This study aimed to investigate methods of deriving acceptable colour standards for watercourses, and to recommend a means of controlling coloured discharges that can be scientifically justified and legally enforced.

Procedures were required that relate spectral absorbance measurements to visual assessment of colour in the river water. This report gives details of the two main approaches examined: serial dilution and river trials.

It was demonstrated that the perception of colour and, therefore, colour standards may be influenced by a number of factors. These include the number of observers and their prejudices, viewing angle and conditions, the natural colour of the river, its depth and turbidity. It was recommended that a protocol for setting standards be derived.

The use of a simple mass-balance approach to setting discharge consents was examined and found to be practicable.

A review of methods available for colour removal is contained in *Project Record P2/i275/1*.

Publication Ref: R&D Project Record P2/i436/1

Removal of Colour from Industrial Dyehouse Effluent Using Biosorption

Doherty S M (1996)

Department of Chemical Engineering, University of Leeds

Project No. P2-436

Commissioned Programme: Water Quality

There has been considerable public complaint about visual pollution from dye wastes discharged via sewage works or directly to the river. This project, funded jointly by the Agency and industry, aimed to research new and cost-effective processes to remove colour from textile dye waste effluents.

Water quality assessment and sampling were undertaken at an industrial dyeworks and nearby sewage treatment works (STW) on the River Severn in the Midlands. A literature review showed that many biosorbents had the potential to remove colour contaminants and metal ions. Three were examined in the laboratory and one – DPXA – selected for further work on a pilot scale.

The report contains details of the work and its findings. It was concluded that the cost of in-house colour removal may be prohibitive for small textile firms, but that the treatment might be undertaken at the STW, with an appropriate charge levied on the dyeworks.

Publication Ref: R&D Technical Report P175 (CIRIA Report 167)

Use of Industrial By-Products in Road Construction – Water Quality Effects

Baldwin G *et al* (1997)

Construction Industry Research and Information Association

Project No. P2-537

Commissioned Programme: Water Quality

The requirement for aggregates in the UK is forecast to increase. It is widely believed that demand will be difficult to meet over the long term, and there is pressure to reduce reliance on quarried material. The use of industrial by-products and reclaimed materials as aggregates in construction might have environmental and economic benefits. However, concern over their potential to cause ground and surface water pollution has inhibited their uptake.

This collaborative project examined whether industrial by-products and reclaimed materials used in road pavement foundations and earthworks are likely to cause contamination of ground and surface water. Testing allowed the hydraulic permeability of a number of by-products to be compared with that of conventional aggregate foundations under a range of conditions.

The report contains the details, results and conclusions of the work. In addition, the testing procedures developed here provide a methodology for further research on materials not yet analysed.

Publication Ref: R&D Technical Report P3

Bioremediation Technology Research

Houlden L and Whittome A (1997)

Geraghty & Miller International, Inc

Project No. P2-623

Commissioned Programme: Water Quality

The Agency is responsible for ensuring that contaminated land is remediated to the extent required to protect human health and the environment, including controlled waters.

The objective of this study was to provide specialist advice on bioremediation technology for groundwater amelioration, including assessing the suitability of sites for the application of such techniques.

This report reviews current knowledge and research, and assesses experience in other countries for its relevance to the UK. It concludes that bioremediation offers the potential for cost-effective solutions for a wide range of contaminants. It has the particular advantage that contaminants are destroyed rather than simply transferred, as is the case with many other approaches.

The report identifies the need for a UK programme to develop remediation technology, and recommends that the Agency develop a key role in this.

Other outputs from this project are:

R&D Technical Report P2: Groundwater Pollution Research Reviews

R&D Technical Report P4: Products Enhancing Biodegradation of Hydrocarbons

Publication Ref: R&D Technical Report P4

Products Enhancing Biodegradation of Hydrocarbons

Davys J and Houlden L (1996)

Geraghty & Miller International, Inc

Project No. P2-623

Commissioned Programme: Water Quality

Several products currently claim to enhance the degradation of oil and related hydrocarbons by providing a mixture of biologically active components. This study aimed to review and assess the validity of these claims.

Literature searches were conducted, manufacturers contacted and independent opinion obtained from UK experts in the field of hydrocarbon degradation. Attention was paid to the completeness of hydrocarbon breakdown, the operating conditions required for efficient operation, by-products and implications for the maintenance of oil interceptors.

Based on this information, the report reviews the claims for effectiveness of biodegradation-enhancing products and recommends future testing.

The review identified no independent research into the performance of biodegradation-enhancing products in interceptors. It recommends that the Agency consider its own programme of testing in this field, followed by the production of guidance notes.

Other outputs from this project are:

R&D Technical Report P2: Groundwater Pollution Research Reviews

R&D Technical Report P3: Bioremediation Technology Research

Publication Ref: R&D Technical Report P176

Building a Cleaner Future – Construction Site Pollution Prevention

Construction Industry Research and Information Association (1996)

Project No. P2-649

Commissioned Programme: Water Quality

Construction and demolition activities form the largest single industrial sector in the Agency's annual report on incidents of water pollution. Working with the industry – particularly the Construction Industry Research and Information Association (CIRIA) – the Agency sought to develop a strategy for dealing with this.

This project aimed to produce a training video for use on induction courses for those working on construction sites.

A steering group of representatives from industry, CIRIA and the Agency ensured that information on the video was accurate and appropriate, and advised on marketing.

The three main outputs were:

- a 15-minute video explaining the risks and impacts of pollution from construction sites;
- a 20-page booklet providing background information for trainers presenting the video;
- a wall poster to remind viewers of the video's key messages.

Publication Ref: R&D Technical Report P19

Review of the Use of Chlorine for Sewage Disinfection

Consultants in Environmental Sciences Ltd (1996)

Project No. P2-686

Commissioned Programme: Water Quality

This report forms an addendum to *R&D Note 229*. It updates a review by the Agency of research into the effects of chlorination as a wastewater disinfection process.

The study found that chlorination is effective at removing indicator bacteria (faecal and total coliforms), but much less effective against more robust organisms such as enteroviruses and F+ coliphage. It confirmed the production during disinfection of halogenated by-products, and demonstrated a direct link between chlorination and ecotoxic effects. Concerns were also noted about the maintenance of appropriate doses of chlorine.

The results of the study have been used to update the Agency's policy for the regulation of disinfected discharges.

Publication Ref: R&D Project Record W1/003/1

Nutrient Management in Rivers

Harper D (1997)

Department of Biology, University of Leicester

Project No. W1-003

Commissioned Programme: Conservation

Nutrients are an important constituent of water quality and have significant ecological effects, including blue-green algal blooms in eutrophic waters. The Agency has responsibilities to maintain water quality and conserve aquatic fauna and flora. In addition, recent EC directives have placed increased importance on the monitoring, control and management of nutrients in surface waters.

This project was a joint venture between the Agency and English Nature to update current knowledge on nutrients in rivers. It took the form of a two-day workshop aiming to achieve consensus over:

- the ecological effects of nutrients in rivers;
- standards – particularly of phosphorous – and the relationship between concentration standards and flow and sediment interactions.

Experts from the Agency, English Nature and others addressed such areas as ambient concentrations, ecological impacts, monitoring methods and drivers for eutrophication control. A business case was considered for eutrophication control, including research needs and approaches to a future management strategy.

Publication Ref: R&D Publication 2 (CIRIA Report 180)

Review of the Design and Management of Constructed Wetlands

Nuttall P M, Boon A G and Rowell M R (1997)

Construction Industry Research and Information Association

Project No. W1-552

Commissioned Programme: Conservation

More than 300 man-made wetlands are used for waste-water treatment in the UK. Some of these are successful, but others have been ineffective. There was a need to investigate the reasons for these successes and failures, and to identify criteria critical to the design of wetlands for treating different types and quantities of waste water.

Drawing on the experience of designers and managers in the UK, this study examined and interpreted the current design operation of constructed wetlands. The resulting review details their benefits and limitations for treating domestic, agricultural and industrial wastewater, and urban and highway run-off.

The report is in three parts. Part A gives guidance on identifying appropriate design and management for each given combination of influent source, performance objectives and environmental requirements. Part B contains supporting information on design, management, cost and environmental considerations. Part C gives information from site visits and case studies of constructed wetlands in the UK.

Publication Ref: R&D Technical Report W109

Fluvial Design Guide

Binnie Black and Veatch (1997)

Project No. W5-027

Commissioned Programme: Flood Defence

This guide aims to provide engineers and others working for the Agency with the information they need to design river works that are effective, appropriate and safe. It gives guidance on the basic procedures involved in the design of river works, identifies those factors needing consideration at the design stage and provides references for further reading. It is intended to help designers to work effectively and project managers to run design contracts efficiently.

The guide is in two parts. “Basic Techniques” includes chapters on geomorphology, flow prediction, hydraulics, tide and surge level prediction, data collection and modelling. The second part – “Design Considerations” – covers channel modifications, flood storage arrangements, flood walls and embankments, river structures and mechanical/electrical equipment.

The manual will be reviewed and updated to address new developments in theory and practice and to reflect user feedback.

Publication Ref: R&D Technical Report W85

Water Level Management Plans – Scoping Study

Noble D (1997)

David Noble and Associates

Project No. W5-033

Commissioned Programme: Flood Defence

The Agency prepares and reviews water level management plans (WLMPs) for river systems that impact directly or indirectly upon Sites of Special Scientific Interest (SSSIs). WLMPs may be extended in the future to cover non-SSSI situations on waterways within the Agency's designated main river system.

This scoping study was commissioned to review the experience and issues arising so far in the preparation of WLMPs and to make recommendations for further research.

The study identified a number of difficulties associated with the preparation of WLMPs, many of them consistent across the Agency. Although they have been substantially overcome, they have resulted in extended timescales and limited hard evidence supporting the selection of water levels. The study highlights areas of concern, and suggests that the quality of many WLMPs will be confirmed only when they are reviewed.

Many of the problems encountered with WLMPs are to be expected in projects of this nature and, as plans are site-specific, no model can provide significant assistance. However, given the likely extension of the WLMP concept, further work in this area is suggested.

Publication Ref: R&D Technical Report W88

Benchmarking and Scoping Study of Hydraulic River Models – Stage Two: Final Report

Crowder R A, Chen Y and Falconer R A (1997)

University of Bradford

Project No. W5-508

Commissioned Programme: Flood Defence

The Agency is a major user of hydraulic river modelling software, and this study aimed to assist personnel in choosing the most suitable package for a given project.

The objective was to undertake benchmarking and scoping tests on all hydrodynamic and backwater models used by the Agency, although flow routing, water quality and sediment transport models were not included. Tests simulated the various features of a river system, including weirs, sluices, loops, culverts, bridges, embankments and tidal waves. User facility and maintenance support were also assessed for each modelling package.

The report gives the details and results of each benchmarking and scoping test. It includes a performance chart to indicate the suitability of each package for modelling a particular problem and for producing acceptable results.

Publication Ref: R&D Report 31 (CIRIA Report 157)

Guidance on the Disposal of Dredged Material to Land

Brooke J *et al* (1996)

Construction Industry Research and Information Association

Project No. W5-516

Commissioned Programme: Flood Defence

This project was funded by the Agency, British Waterways, the Manchester Ship Canal Company and Port of London Authority. It aimed to review guidance on the disposal and management of dredgings in order to develop best practice guidelines in accordance with the Waste Management and Licensing Regulations of 1994. These will involve operators in procedures for licence application and, where applicable, exemption registration.

This report gives guidance on the safe, economical and effective disposal and management of dredgings, consistent with the above regulations. The guidance covers the selection and planning of a disposal method and includes legal considerations, information requirements and application procedures. Information is provided for use when applying for a licence or registering for an exemption.

Publication Ref: R&D Technical Report W16 (CIRIA Ref: FR/CP/40)

Hydraulic Design of Culverts

Ramsbottom D, Day R and Rickard C (1996)

CIRIA

Project No. W5-589

Commissioned Programme: Flood Defence

Culverts are covered channels or pipelines for conveying a watercourse under an obstruction, and are one of the most common forms of drainage structure. The literature on their design has previously been aimed at specialist hydraulic engineers and lacks a standard procedure.

This report, intended for use by engineers without specialist knowledge of hydraulics, contains clear, concise guidelines for the design of culverts. It describes their hydraulic behaviour and provides an overall process for their design. Information is given that can be used to analyse and assess existing culverts. The hydraulic design procedure contains worked calculations, and the report includes examples of good design practice.

Publication Ref: R&D Technical Report W38

Guidance on Development in Areas at Risk from Tidal Flooding

Arup Economics & Planning (1996)

Project No. W5-685

Commissioned Programme: Flood Defence

The Agency has limited powers to control development in areas at risk from tidal flooding. It is responsible, however, for ensuring that local planning authorities have sufficient information to make informed and sound planning decisions.

This project aimed to:

- quantify the scale of the problem of new development in tidal risk areas;
- analyse the assessment of degree of risk and the advice given;
- interpret government guidance and relevant research;
- identify policy options to ensure a consistent approach across Agency regions.

Research included meetings with Agency staff and confirmed that there is currently no consistent approach to such development. Agency concerns were rarely identified in local authority development plans, and planning authorities were concerned at the lack of guidance.

The report identifies and summarises statutes, planning guidance, previous research, existing practices and input into planning appeals. It identifies parameters for consideration when assessing risk and giving advice, and proposes a framework for establishing Agency policy. Flood risk maps must be produced, and advice on producing these is provided.

Publication Ref: R&D Technical Report W41

Earth Embankment Fissuring Manual

Frith C W, Purcell A M and Powell A S (1997)

Binnie Black and Veatch

Project No. W5-724

Commissioned Programme: Flood Defence

The Agency is responsible for thousands of kilometres of fluvial, tidal and coastal defences. Most are earth embankments of locally won materials and many are reported to be fissured. Their maintenance and repair accounts for a significant proportion of the Agency's flood defence budget, therefore the effect of fissures on the standard of service of embankments needs to be clarified.

This project aimed to identify the scope of the problem, recommend procedures for assessing an embankment's tendency to fissure, and investigate measures that may be adopted to limit or prevent the occurrence of fissuring.

The manual is the main output from the study. It provides a guide to the design, construction and maintenance of flood defence earth embankments with regard to the prevention or control of fissuring. It includes chapters outlining the scope of the problem, the causes and effects of fissuring of clay embankments, and suitable assessment, remedial design and maintenance methods. Several recommendations are made for the maintenance and monitoring of earth embankments and for further research into the mechanisms of embankment fissuring.

Publication Ref: R&D Technical Report W105

Biological Control of Weeds – A Scoping Study of the Feasibility of Biological Control of Aquatic and Riparian Weeds in the UK

Greaves M

Institute of Arable Crop Research, Long Ashton (1996)

Project No. W5-734

Commissioned Programme: Flood Defence

Weed control of native and introduced species has traditionally included labour-intensive mechanical means and, increasingly, the use of herbicides. Concern over the use of chemical herbicides, especially in or near sensitive environments such as water, has led to growing interest in the use of biological control mechanisms.

This project assessed the potential to control important aquatic and riparian weeds in the UK using biological control methods. The scoping study reviewed worldwide literature on such techniques, and considered their benefits and limitations. It concluded that they had the potential to be suitable, cost-effective and environmentally acceptable.

Non-native species are best controlled by a "classical" biological control strategy, in which an agent isolated in the weed's native range is released in the infested area and allowed to establish, reproduce and spread, thereby controlling the weed throughout that area. This achieves long-term, even permanent, reduction of the weed population below a damage threshold.

Native weed species should be treated using the inundation or microbial herbicide strategy. Here the weed species is treated with a single massive inoculum of an agent which is a native species and will die back to a background level once its target is controlled.

The study suggests the potential for biological control of a number of species, and outlines the associated costs and benefits.

3.11 Conserving the Land

3.11.1 The Issues

Our land is a vital resource that needs to be conserved. To do this, we need R&D to help us to know its extent, nature, quality and location. Past pollution has created areas of contamination which have to be identified and managed effectively in order to reduce present problems concerning public health and environmental pollution and to return land to appropriate use. Where past land-use practices have left soil unprotected, methods are required for tackling existing problems and preventing future erosion. Farming techniques may need to be reviewed so that activities do not pollute the land or water. Much of England and Wales is liable to flooding. This is detrimental to land conservation and may well be worsened by climate change. New and more sustainable methods of flood defence are being developed and implemented in both coastal and inland areas.

3.11.2 Under the Environmental Strategy, the Agency will:

- influence the planning system to prevent developments in the wrong places;
- implement the flood and coastal defence policy as advised by MAFF and the Welsh Office;
- secure an adequate level of investment in flood defence;
- provide floodplain surveys to local planning authorities;
- discourage development on the floodplain;
- work with nature to reduce coastal flooding;
- develop new methods to survey and manage flood defences;
- report regularly on the state of flood defences;
- identify the state and extent of the problem of soil erosion;
- develop a soil erosion alleviation strategy, including guidance on best practice;
- work with local authorities to identify and report on the extent of contaminated land;
- regulate identified "special" contaminated land sites effectively;
- investigate the specific risks and remediation needs of contaminated land;

- investigate and alleviate the effects of soil acidification in upland areas;
- measure the effectiveness of nitrate reduction measures in designated nitrate vulnerable zones;
- develop methods for monitoring the "state" and quality of potentially contaminated soil.

3.11.3 Outputs

This section lists the two output produced in 1997/98 that are most relevant to this key environmental theme, although they may also have a connection to other frameworks and/or themes.

The two outputs that fall within the environmental theme of Conserving the Land are:

Technical Report P107
Literature Assessment of Ecotoxicity Testing for the Evaluation of Contaminated Land

Technical Report W12
Historic Changes in Saltmarshes

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report W12

Historic Changes in Saltmarshes

Carpenter K E and Pye K

HR Wallingford Ltd

Project No. W5-566

Commissioned Programme: Flood Defence

The objective of the study was to analyse historic changes in saltmarshes and establish the likely reasons for these changes, and to identify management methods appropriate to counter-balance the increasing pressures placed on saltmarshes. The reason for this is that saltmarshes form a first line of defence from coastal flooding that can substantially reduce the cost of man-made defences.

The study charts regional changes in saltmarsh extent and vigour in England and Wales, and the likely causes of these changes. The relative importance of the various forcing factors (including hydraulic, chemical and human) that have the potential for driving the change were studied. Natural hydraulic changes, that is, changes in wave heights, storm frequency, wind direction, relative sea level rise, tidal range and channel migration, were established using a combination of hindcast modelling, analysis of wind and water level records and literature review. The variations in these forcing factors were correlated to saltmarsh changes (determined from site visits and literature review) in order to determine the relative importance of each one. The significance of non-hydraulic natural factors such as sediment chemistry and sediment supply on saltmarsh change was also considered, as was the impact of human activity. For each potential forcing factor, guidelines were provided on management methods which would counteract or combat saltmarsh loss.

The study concluded that several factors have contributed to saltmarsh change over the last few centuries. Their relative importance varies both spatially and temporally.

3.12 Managing Our Freshwater Fisheries

3.12.1 The Issues

Our freshwater fisheries are a valuable resource and act as significant indicators of the state of the environment. The Agency has responsibilities to protect, improve and develop fish stocks, to protect and enhance the environment for fish, to control fishing to ensure that fisheries are sustainable, and to improve the environment for fishermen. Fisheries have a significant social and amenity value in England and Wales.

Both quality and quantity of fish stocks are important. The Agency needs R&D to help it assess the status of its fisheries, and to determine appropriate management responses. We need to know what stocks we have, and the pressures on them. We need to understand how best to develop fish stocks, improve the environment for fish, and pay for this.

3.12.2 Under the Environmental Strategy, the Agency will:

- secure a more market-oriented funding base for fisheries management;
- review the economic basis of fisheries management;
- introduce a standard fisheries classification scheme;
- monitor every river fishery over a five-year rolling cycle;
- restore spawning ground for freshwater fish;
- tackle mine-water pollution to improve headwater spawning grounds;
- implement a programme of minimum acceptable flows for rivers;
- develop management strategies for salmon, trout and coarse fisheries;
- make significant reductions to poaching and rod licence evasion;
- consider the economics of fixed fines for rod licence offences;
- consider the introduction of mandatory rod licence display systems;
- investigate the factors affecting the viability of our unique freshwater fisheries populations.

3.12.3 Outputs

This section lists the 24 outputs produced in 1997/98 that are most relevant to this key environmental theme, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those outputs available to the general public.

The principal outputs that fall within the environmental theme of Managing Our Freshwater Fisheries are:

Technical Report W95
River Fisheries Habitat Inventory (Phase 1) - Scoping Study

Technical Report W33
Genetic Stock Discrimination of Atlantic Salmon at Catchment or Sub-Catchment Levels

Technical Report W90
Genetic Stock Identification (GSI) in Atlantic Salmon: Phase 1

Technical Report W93
Development of Lightweight Backpack Electric Fishing Gear

Technical Report W60
Review of Sea Trout Fecundity

Project Record W2/19/1
Database and Atlas of Freshwater Fishes in the UK: Pilot Project 1996/97

Technical Report W75
Factors Affecting Coarse Fish Recruitment

Technical Report W96
Evaluation of the Close Season in Canals

Report 30
The Impact of Land Use on Salmonids: A Study of the River Torridge Catchment

Technical Report W67
Changes in Agricultural Land Use in the Torridge Catchment 1952 to 1988

Technical Report W68
Studies of Historical Water Quality in the Torridge Catchment and Comparisons of Current Water Quality in Intensively and Non-Intensively Farmed Sub Catchments

Technical Report W69
In Situ Salmon Embryo Experiments, Sedimentological Survey and Juvenile Salmon Bioassay Experiments in the Torridge Catchment

Technical Report W70
Studies of Adult Salmonid Catches and Juvenile Salmonid Populations in the Torridge Catchment

Technical Report W23
Design and Use of Open Channel Resistivity Fish Counters - Advisory Manual

Note 386
The Regulation of Fish Farming by the National Rivers Authority

Technical Report W5
The Effects of Stocked Brown Trout on the Survival of Wild Fish Populations

Technical Report W74
A Review of Consented Trout Stockings into Riverine Environments

Technical Report W64
Spawning Escapement Targets for Atlantic Salmon

Technical Report W65
The Transportation of the Maximum Gain Salmon Spawning Target from the River Bush (N.I.) to England and Wales

Technical Report W66
Smolt Trapping Using Acoustic Techniques, Phase 1

Technical Report W44
Restoration of Riverine Salmon Habitats: A Guidance Manual

Technical Report W81
The Movements of Atlantic Salmon (Salmo salar L.) and Sea Trout (Salmo trutta L.) in Estuarine Migratory Behaviour of Salmon and Sea Trout

Technical Report W92
The use of a Hydroacoustic counter for Assessing Salmon Stocks

Technical Report W101
An Assessment of Cormorant Depredation on Stillwater Coarse Fish Populations in the Lea and Colne Valleys of the Thames Catchment

Technical Report W91
Development of a Life Cycle Simulation Model for Atlantic Salmon – Scoping Study

Technical Report W58
The Status of Headwater Stream Fish Populations and their Tolerance to Low-Level Habitat Degradation

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report W33

Genetic Stock Discrimination of Atlantic Salmon at Catchment or Sub-Catchment Levels

Youngson A (1996)

Scottish Office Agriculture and Fisheries Department

Project No. W2-007

Commissioned Programme: Fisheries

Genetic stock identification (GSI) determines individual population proportions in a mixed stock sample. It is based on a mathematical comparison of the genetic composition of the sample, with baseline data for each of the contributing stocks.

The main objective of this project was to assess the potential application of GSI to migratory salmonids in order to identify catchment origins of stock components of various sea age and run timing traits.

This report is a preliminary review to define the work necessary to achieve the objectives of the study, and to draft its terms of reference. It finds that the principles of GSI are sound, but that it is some way from being a practical fisheries management technique. The potential sources of error affecting its accuracy and precision can be identified, estimated and therefore modelled. Such modelling of GSI and its application to real situations need to be developed in an appropriate local context.

Publication Ref: R&D Technical Report W90

Genetic Stock Identification (GSI) in Atlantic Salmon: Phase 1

Thompson C and Ferguson A (1997)

School of Biology and Biochemistry, Queen's University, Belfast

Project No. W2-007

Commissioned Programme: Fisheries

Phase 1 of this project developed the work outlined in *Technical Report W33*. It aimed to assess the potential applications of GSI to migratory salmonids, in order to identify catchment origins of stock components of various sea age and run timing traits. Data from genetic studies of Atlantic salmon and sea trout were used in modelling and assessing the application of GSI to the discrimination of salmonid stock components.

The study indicates that the GSI approach is appropriate for the analysis of inter- and intra-drainage stock mixtures, with errors in attribution typically less than 5-10 per cent. The potential value to fishery management of the new technique of DNA profiling of parent-offspring combinations is described. Recommendations are made for future empirical studies in test catchments to demonstrate the applicability of the technique.

Publication Ref: R&D Technical Report W60

Review of Sea Trout Fecundity

Solomon D J (1997)

Project No. W2-013

Commissioned Programme: Fisheries

Developments in the management of salmonid stocks mean that a non-destructive method is needed for determining the fecundity of fish.

The aims of this project were to:

- review existing results of fecundity studies on sea trout;
- consider the patterns and extent of variation;
- consider the adequacy of the available information for fisheries management purposes;
- recommend appropriate further investigation.

Data on the fecundity of sea trout stocks from the British Isles, Norway and France were reviewed and compared, using a formula to link number of eggs per female with fish length for each stock, and for the stocks of each area.

The length/fecundity relationships for different stocks were clearly different, but in most cases the raw data were not available to establish the statistical significance of this. The report gives details of other aspects examined and concludes that further refinement of our understanding of sea trout fecundity is not particularly urgent.

Recommendations are made regarding the acquisition and review of further data, and approaches to gathering and storing samples.

Publication Ref: R&D Project Record W2/19/1

Database and Atlas of Freshwater Fishes in the UK: Pilot Project 1996/97

Davies C E and Harding P T (1997)

Institute of Terrestrial Ecology

Project No. W2-019

Commissioned Programme: Fisheries

Fish are the only vertebrate group for which there is no comprehensive source of information on the occurrence of species in Britain. The Agency therefore joined the Institute of Terrestrial Ecology (ITE) and the Joint Nature Conservancy Council (JNCC) in undertaking a scoping study into the feasibility and costs of producing a database and atlas of freshwater fishes.

A questionnaire was devised to ascertain the availability of data and minimum user requirements of a database. Trial data entry was performed and the feasibility of producing a database and atlas assessed. Details of the work, its findings and recommendations, are presented in this report.

Following the success of the pilot project, a database and atlas will be produced as a further phase of this work.

Publication Ref: R&D Technical Report W75

Factors Affecting Coarse Fish Recruitment

Pinder L C V *et al* (1997)

Institute of Freshwater Ecology
International Fisheries Institute, Hull
SGS Environment
University of Hertfordshire

Project No. W2-023

Commissioned Programme: Fisheries

The effective management of fisheries requires an understanding of the factors affecting the abundance of fish populations. The Agency commissioned four contractors to scope out a study to identify the factors affecting recruitment in riverine coarse fish populations, their impact and the mechanisms by which they operate.

The contractors were asked to outline and justify:

- location and duration of the study;
- target fish species;
- sampling methods, their frequency and level of precision;
- biotic and abiotic factors to be measured and the precision with which they should be determined;
- how data should be analysed;
- costs of the programme;
- how the studies might relate to management issues and influence best practice in the Agency.

The four reports contained here give details and findings of the work. They will assist the Agency in identifying priority areas for the investigation and the resources needed to ensure successful completion.

Publication Ref: R&D Technical Report W96

Evaluation of the Close Season in Canals

Hendry K and Cragg-Hine D (1997)

APEM Ltd

Project No. W2-025

Commissioned Programme: Fisheries

There is currently an inconsistent approach to the freshwater fish close season in canals in England and Wales. To support future policy development, the Agency commissioned a study to identify whether or not angling during the close season in canals was detrimental to fish populations.

The study produced criteria for differentiating between canals and other water bodies. It undertook a review of literature on canals, close seasons and the impact of angling, and examined data indicating the potential effects on fish populations of maintaining or removing the close season.

Expert opinion was consulted, confirming the view from data analysis that angling during the close season was not detrimental to fish populations. Interviews with angling organisations and the tackle industry suggested that removal of the close season would be beneficial in socio-economic terms.

Details of the study are contained in this report, which finds no justification for maintaining a close season for coarse fish angling on canals.

Publication Ref: R&D Report 30

The Impact of Land Use on Salmonids: A Study of the River Torridge Catchment

Naismith I *et al* (1996)

WRc plc

Project No. W2-152

Commissioned Programme: Fisheries

This project, funded by the Agency and MAFF, investigated evidence linking changes in agricultural land use to deterioration in water quality and salmonid populations.

The study compared intensively and non-intensively farmed sub-catchments for land use, water quality and wild juvenile salmonid populations. The details and findings are contained in this report.

Water quality in the non-intensively farmed sub-catchments was consistently better than that in the intensively farmed areas, indicating that changes in landuse have caused a deterioration in water quality. Embryo survival was lower in intensively farmed sub-catchments, but the survival of juvenile salmonids was not adversely affected by water quality. Localised evidence elsewhere in the Torridge catchment of polluting discharges and anthropogenic impacts implied that poor waste management might affect the long-term degradation of salmonid stocks.

Recommendations are made for the future protection of salmonid stocks in rivers where changes in land use occur.

Publication Ref: R&D Note 386

The Regulation of Fish Farming by the National Rivers Authority

Howarth W and McGillivray D (1995)

University of Kent

Project No. W2-388

Commissioned Programme: Fisheries

The role of the National Rivers Authority (now the Environment Agency) in regulating fish farming is based on environmental and legal issues.

This project aimed to:

- outline the legal powers and duties of the NRA with respect to fish farming;
- ascertain the practical use being made of existing legal provisions relating to planning authorisations, fish movements, disease control, abstraction licensing, discharge consenting and crayfish cultivation;
- highlight shortcomings in the current provisions;
- evaluate the extent to which legal research can assist the Agency in the future.

The study gathered and evaluated ideas and examples of best practice from the regions, and found the need for a consistent approach. It recommends some law reforms and suggests that the development of new laws and policies will require further research in the future.

Publication Ref: R&D Technical Report W74

A Review of Consented Trout Stockings into Riverine Environments

Barnard S (1997)

WRc plc

Project No. W2-452

Commissioned Programme: Fisheries

This study is part of an investigation into the effects of stocked trout on wild salmonid populations in rivers. It undertakes a review of stocking consents (Section 30 of the Salmon and Freshwater Fisheries Act, 1975) relating to the introduction of trout into rivers in England and Wales.

The review assesses:

- the range and species of trout stocked into rivers in England and Wales;
- the range of stocking densities employed;
- the nature of spatial and/or temporal patterns in stocking.

This report contains details of the study's methods, results and findings.

Recommendations include the adoption of a single national Section 30 consent application form and the development of an electronic database to facilitate the storage and retrieval of processed applications.

Publication Ref: R&D Technical Report W64

Spawning Escapement Targets for Atlantic Salmon

Wyatt R J and Barnard S (1997)

WRc plc

Project No. W2-551

Commissioned Programme: Fisheries

Spawning targets have been used in the management of Canadian salmon stocks for almost 20 years, but their application to eastern Atlantic rivers has only been considered recently. A key objective of the Agency's national salmon management strategy is to develop targets for the principal salmon rivers of England and Wales as a means towards improved resource management.

The objectives of this project were to:

- review existing stock recruitment-derived spawning targets for salmon in the eastern Atlantic;
- develop alternative methods of spawning target derivation based on optimum levels of juvenile abundance and rod and net catch;
- evaluate the use of these targets in the Agency's management of fisheries.

This report examines the family of curves used in stock recruitment modelling, and applies them to existing data available from the Bush, Girnock Burn and a number of Canadian rivers. Similarities are explored between fitted curves and their associated targets, and the implications discussed of transporting targets between rivers.

Novel approaches to target setting are described, including the use of a GIS-based habitat model to predict carrying capacity from altitude and stream order. This is refined in *Technical Report W65: The Transportation of the Maximum Gain Salmon Spawning Target from the River Bush (N.I.) to England and Wales.*

Publication Ref: R&D Technical Report W65

The Transportation of the Maximum Gain Salmon Spawning Target from the River Bush (N.I.) to England and Wales

Wyatt R J and Barnard S (1997)

WRc plc

Project No. W2-551

Commissioned Programme: Fisheries

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The objectives of this project were to:

- review existing stock recruitment-derived spawning targets for salmon in the eastern Atlantic;
- develop alternative methods of spawning target derivation based on optimum levels of juvenile abundance and rod and net catch;
- evaluate the use of these targets in the Agency's management of fisheries.

Technical Report W64: Spawning Escapement Targets for Atlantic Salmon describes a method of transporting stock recruitment curves between rivers using a GIS-based habitat model.

The model is refined here – *Technical Report W65* – to derive curves and targets specific to the Agency's principal salmon rivers. These have been incorporated into the Agency's *Salmon Action Plan Guidelines,* where procedures are also described for target setting and compliance assessment.

Publication Ref: R&D Technical Report W66

Smolt Trapping Using Acoustic Techniques, Phase 1

Welton J S *et al* (1997)

Institute of Freshwater Ecology

Project No. W2-573

Commissioned Programme: Fisheries

During their downstream migration, salmon and sea trout smolts are vulnerable to entrainment and mortality in fish farms, hydro-power schemes and potable water intakes. This project studied the effectiveness of acoustic screens in diverting salmon smolts from such intakes. A further application for the screens would be to divert smolts into trapping and counting facilities, thereby maximising the proportion of a smolt run being sampled.

This report details Phase 1: a literature review and initial field trials on the River Frome in Dorset. Acoustic bubble screens were tested on the main river and on a leat.

Results showed that screens in the leat were effective in diverting smolts. Evaluation of the main river screen using mark-recapture methods had limited success, but visual observation suggested that it was operating at high efficiency.

A second phase of the project is required to evaluate the main river screen and to develop an automatic smolt counter, with a view to obtaining absolute estimates of the annual salmon smolt production for the River Frome.

Publication Ref: R&D Technical Report W44

Restoration of Riverine Salmon Habitats: A Guidance Manual

Hendry K and Cragg-Hine D (1996)

APEM Ltd

Project No. W2-584

Commissioned Programme: Fisheries

Atlantic salmon are a valuable resource requiring national and international management. The species is important for its ecological interest and the economic, recreational and aesthetic benefits it provides.

The Agency's national strategy for the management of salmon in England and Wales recognises habitat restoration as an efficient, self-sustaining and cost-effective means of increasing fish production. The objective of this project was to review existing techniques for the creation and restoration of habitats and provide guidelines for future schemes.

Based on a review of published and unpublished literature, the guidance manual is organised in three parts. Part 1 gives background information that should underpin any restoration initiative. It discusses river types and influential processes, as well as salmon habitat requirements and critical factors leading to habitat degradation. Part 2 reviews existing habitat restoration techniques and provides practical guidance. Part 3 provides project management guidelines for future initiatives.

Habitat restoration in the UK is still in its infancy, with little pre- or post-scheme appraisal. It is recommended that a database of restoration is maintained by the Agency to inform future schemes.

Publication Ref: R&D Technical Report W81

The Movements of Atlantic Salmon (Salmo salar L.) and Sea Trout (Salmo trutta L.) Smolts in the Impounded Estuary of the River Tawe, South Wales

Moore A

Ministry of Agriculture, Fisheries and Food

Project No. W2-312

Commissioned Programme: Fisheries

The movement of smolts through estuaries is a short but critical stage in the life cycles of migratory salmonids. Knowledge of their behaviour at this time has been very poor, constraining the Agency's ability to predict impacts on fish stocks caused by tidal barrages or other developments that may alter water quality of hydrographic features of estuaries.

This study was originally undertaken as a collaborative venture between MAFF (DFR) and NRA, and a previously released NRA report (*R&D Note 349*) described the results of a study of migratory behaviour of smolts in the Conwy estuary, a waterway with no physical obstructions present. Phase 3 of this study describes the results of a two-year study on the migratory behaviour of smolts in the River Tawe, an estuary which has been impounded by a barrage. An important aspect of this phase of the project was to determine the potential impact of the barrage on smolt migratory behaviour.

No relationships were found between migration and water quality, although there was an apparent relationship between smolt movement and river flow. Smolts were trapped in freshwater when water levels were rising, and there was also a strong correlation between river flow and the speed of movement over the ground of the migrating smolts.

Recommendations for further work were made, including the impact of contaminants in impounded estuaries on smolt survival, extension of the coastal tracking studies, impact of avian predators on salmonids and investigations of lock operation on smolt emigration.

Publication Ref: R&D Technical Report W92

The Use of a Hydroacoustic Counter for Assessing Salmon Stocks

Gregory J, Clabburn P and Robinson L

Environment Agency

Project No. W2-486

Commissioned Programme: Fisheries

The project evolved through identification of the need for a reliable stock assessment technique for wide application, and more specifically from a requirement to collect reliable data on the abundance and timing of the spring salmon run on the Wye. A hydroacoustic counter was identified as possibly the only technique that could enumerate the migration of salmon in rivers such as the Wye. No long-term trial of acoustic techniques had been carried out in the UK previously, although such equipment is used routinely in North America.

The project was carried out by staff of the South East Area Environmental Appraisal Unit of the Agency, based at St. Mellons, near Cardiff. The resource implications for year-round production of counts are discussed.

A method of validating the acoustic data using underwater video cameras was trialed. The results from this indicated that the counter detected 80 per cent of fish passage under trial conditions.

Despite some problems, the technique was shown to represent a potentially powerful management tool for quantifying salmonid migration in a riverine environment. Further validation work is required and recommendations on suitable techniques are made in the report.

Publication Ref: R&D Technical Report W101

An Assessment of Cormorant Depredation on Stillwater Coarse Fish Populations in the Lea and Colne Valleys of the Thames Catchment

Pilcher M W and Feltham M J (1997)

Environment Agency In-house
Hertfordshire and Middlesex Wildlife Trust

Project No. W2-596

Commissioned Programme: Fisheries

Concerns have been raised about the perceived adverse effects of cormorant depredation at stillwater amenity fisheries. As a result, the Agency commissioned a one-year study based in the south east that aimed to:

- conduct a field experiment measuring the impact of cormorant feeding at a test and control stillwater site where measured populations of three coarse fish species had been introduced;
- report the perceived view of cormorant depredation at angled stillwater sites, using a purpose-designed questionnaire.

This report contains details of the impact experiment, conducted at a lagoon complex in the Lea Valley, Hertfordshire. Observations showed that only a small proportion of lost fish stock could be attributed to cormorants, and the report suggests other possible causes.

Part 2 of the report examines information received from a questionnaire circulated to 350 angling clubs in the Thames North East area. Cormorant occupancy showed clear seasonal and diurnal trends. Other findings related to species and size of fish caught, and showed a recent perceived change in the former. Bird depredation is again one possible reason for the changes, but the report suggests others.

Publication Ref: R&D Technical Report W91

Development of a Life Cycle Simulation Model for Atlantic Salmon – Scoping Study

Wyatt R J and Barnard S (1997)

WRc plc

Project No. W2-675

Commissioned Programme: Fisheries

Fisheries staff in the Agency frequently base decisions on basic predictive models. This can lead to duplication of effort, and strategic decisions being made without the benefit of recent best practice for population modelling. There is therefore a need to develop a salmon lifecycle model that will promote a common approach to salmon management decision analysis throughout the Agency.

In Phase 1 of this project, a literature review of life cycle modelling and key life stage parameters identified techniques relevant to the development of a salmon model. No existing model fulfilled the Agency's requirements (for example, not all life stages were adequately addressed, or there were weaknesses in risk assessment). Proposals were made for Phase 2 (programming and testing of a prototype model) and Phase 3 (production of user-interface software and user trial) of the project. Both will require innovative approaches to model development.

Publication Ref: R&D Technical Report W58

The Status of Headwater Stream Fish Populations and their Tolerance to Low-Level Habitat Degradation

Mainstone C P, Morgan N and Wyatt R (1997)

WRc plc

Project No. W2-691

Commissioned Programme: Fisheries

Headwaters are highly vulnerable habitats that generally constitute a large proportion of the total water area and riparian length in river catchments. They are important fishery habitats in their own right, and contribute to the wellbeing of the whole catchment fishery resource by providing spawning habitat and nursery areas for juvenile fish.

This project aimed to provide a basis for the strategic management of headwater stream fish populations by assessing their contribution to catchments and their sensitivity to impacts. A two-phase study was defined: a scoping study (Phase 1) and a field investigation (Phase 2).

This report details findings from historical data and a review of literature on headwater fish populations, their vulnerability to threats to their status, and the nature and extent of impacts upon them. Conclusions are reached regarding the definition of headwaters and their vulnerability to impacts. Recommendations are made for Phase 2 of the work.

3.13 Enhancing Biodiversity

3.13.1 The Issues

Human activities, particularly pollution and destruction of habitats, have caused a decline in biodiversity - the variety of all life forms - of species and ecosystems in the UK. Biodiversity is important because we are dependent on biological systems and processes for maintaining environmental systems, and for our health and quality of life. The Agency's conservation duties are reinforced by statutory guidance identifing conservation and enhancement of biodiversity as essential elements of sustainable development. The *UK Biodiversity Action Plan* sets out actions for 116 priority species and 14 key habitats, and identifies other opportunities for enhancing biodiversity.

A major part of the Agency's contribution to biodiversity will be delivered as a result of initiatives implemented for other purposes. R&D will help the Agency to identify how best it can apply its own activities to enhance biodiversity and influence others to do likewise – for example, through LEAPs. The Agency needs to be able to ensure that the right populations of species and varieties are present, and to develop the means of demonstrating the biodiversity benefits of its various activities.

3.13.2 Under the Environmental Strategy, the Agency will:

- play a full part in implementing the EC Habitats Directive;
- play a part in delivering the UK's biodiversity action plan (BAP);
- ensure that BAP commitments are incorporated into the Agency's guidance and LEAPs;
- implement specific regional partnership projects to deliver biodiversity targets;
- allocate specific resources to conservation projects aimed at increasing biodiversity;
- control eutrophication, where feasible, in order to enhance biodiversity;
- improve the management of wetlands for conservation purposes;
- utilise best environmental practice for the protection and restoration of river habitats;
- develop conservation criteria for all Agency environmental licensing activities;
- implement habitat restoration projects for specific rivers and lakes;

- tackle diffuse pollution to protect and improve the aquatic environment;
- investigate species management in the aquatic environment to meet biodiversity targets.

3.13.3 Outputs

This section lists the seven outputs produced in 1997/98 that are most relevant to this key environmental theme, although they may also have a connection to other frameworks and/or themes. Summary information is provided for those outputs available to the general public.

The principal outputs that fall within the environmental theme of Enhancing Biodiversity are:

Technical Report E25
Operational Mechanisms for the Protection and Enhancement of Headwaters – Scoping Study

Project Record W1/013/1
The Agency's Role in River SSSIs, SPAs and SACs

Project Record W1/019/1
Investigation and Monitoring of Anthropogenic Diseases in Wild Animals

Technical Report W86
River Morphology and Plant Relationships

Technical Report W54
Catchment Ecosystem Research and Development – Scoping Study

Technical Report W108
Deeside Rivers Survey: Final Report

Summary Information

The following summaries are provided for those documents available to the general public:

Publication Ref: R&D Technical Report E25

Operational Mechanisms for the Protection and Enhancement of Headwaters – Scoping Study

Furse M T and Symes K L (1997)

Institute of Freshwater Ecology

Project No. E1-696

Commissioned Programme: Environmental Monitoring and Assessment

Headwaters support many rare and specialised taxa, and therefore have a major role in maintaining catchment biodiversity. An earlier project (R&D Project 242) showed that they often had poorer water quality than larger watercourses. This indicated a need to review headwaters on a regional basis and to develop an operational programme to protect and enhance them.

The main objectives of the scoping study were to:

- report the number and length of headwaters in each Region;
- assess the awareness of headwater issues inside and outside the Agency;
- identify areas for further research.

This report contains detailed data regarding headwater sites. A questionnaire was used to test the level of awareness of Agency staff and their advisory committees. The findings are given here, including respondents' recommendations for future R&D studies.

A "Headwaters Factfile", included in this report, aims to increase awareness and stimulate collaboration between the Agency and outside bodies to help them value, protect and improve headwaters. The report makes recommendations on communicating research findings and improving sampling programmes, and offers proposals for further work.

Publication Ref: R&D Technical Report W86

River Morphology and Plant Relationships

Rowell T A, Jeffers J J and Holmes N T H (1997)

Project No. W1-517

Commissioned Programme: Conservation

Through detailed analysis of the Nature Conservancy Council's (NCC) Rivers Database, this project aimed to establish whether river macrophyte communities could be predicted from physical data obtained from maps and field surveys. This would help to determine whether river habitat survey (RHS) could be based on an existing system or required the development of a new one.

The study checked the completeness and reliability of the NCC database, and added further data where appropriate. This enabled the completion of the "environmental variables" component of the NCC database, so that community and species associations can be correlated with a variety of external factors. Details are contained in this report, along with the results of statistical analyses of plant-based macrophyte classification.

The main conclusion is that RHS classification cannot be directly linked to the NCC macrophyte classification system. A new classification needs to be developed, with data collected through the RHS survey programme.

Publication Ref: R&D Technical Report W54

Catchment Ecosystem Research and Development – Scoping Study

Hildrew A G, Hutchinson J D and Ormerod S J (1997)

Queen Mary and Westfield

Project No. W1-531

Commissioned Programme: Conservation

The Agency, the Natural Environment Research Council, English Nature and the Economic and Social Research Council jointly funded a feasibility and scoping study into catchment ecosystem research. This examined the feasibility of undertaking a programme of research and/or development on man's impact on catchment ecosystems, with the aim of enabling better management of catchments on a sustainable basis.

The study reviewed current knowledge and identified key scientific and management questions. Five options for further development and new research were assessed on the basis of costs, benefits, constraints and risks/uncertainties.

This final report concludes that the most beneficial option would be a programme of development, plus a programme of multi-disciplinary research undertaken by a partnership of scientists and users.

Details of the research programme, named CERI (Catchment Ecosystem Research Initiative), include the suggested science programme, approach and location, as well as costs, timetabling and possible management structure. A detailed planning phase is recommended as a next step.

Publication Ref: R&D Technical Report W108

Deeside Rivers Survey: Final Report

Webb A and Bacon P J (1996)

Institute of Terrestrial Ecology

Project No. W1-633

Commissioned Programme: Conservation

This study was carried out on the River Dee in Scotland. Its objective was to establish a sampling strategy for RHS input to catchment management plans, and to integrate it with other survey functions, such as salmonid habitat assessment and conservation evaluation.

The work aimed to:

- describe the physical habitat in order to evaluate current and future potential for wildlife of the streams and rivers and their immediate environment;
- collect information to support salmon fishery management decisions.

The study surveyed 160 sites using RHS, with additional plant species relating to the RHS land-use categories. These were entered into the RHS database and linked to a geographical information system (GIS). The data were analysed in relation to stream width, vegetation and percentage gravel/pebble substrate.

It was found that stream width can be reliably predicted from GIS-derived variables, whereas percentage gravel/pebble cannot. The report recommends further analysis of the data and suggests future survey work for a "rapid appraisal" technique.

APPENDIX 1

R&D Personnel and Management Information

This appendix provides details of those staff involved in the Agencyís R&D programme. R&D is an integral part of the Agencyís activities and, consequently, the participation of programme officers, topic leaders and project managers has been recognised as being central to the successful delivery of the required outputs.

Table A1.1 *Composition of R&D Project Assessment Board (PAB)*

Projects in the national R&D programme are processed by the R&D PAB. It gives approval to projects and recommends authorisation under the scheme of delegation. Powers are delegated from the R&D PAB to the R&D PAB Secretary to avoid undue delays and bureaucracy. Its activities are intended to add value and focus to the R&D Programme.

Mervyn Bramley	Head of R&D (R&D PAB Chair)
James Edwards	R&D Programme Officer (R&D PAB Secretary)
Martin Brocklehurst	Head of EP National Service (Environmental Protection Directorate Representative)
Alastair Ferguson	Environmental Monitoring Strategy Manager (Environmental Strategy Directorate Representative)
Howard Pearce	Head of Corporate Planning (Finance Directorate Representative)
Paul Raven	Head of Conservation (Water Management Directorate Representative)
Jane Williams	Operation Directorate’s Business Planning Analyst (Operations Directorate Representative)
Peter Thomas	Procurement Strategy Manager (Head Office Procurement Representative)

Table A1.2 *Programme Officers and Topic Leaders*

The following table lists the programme officers and topic leaders who are in place in the 1998/99 financial year. This has been produced so that if anyone has a query over a specific project they can contact the relevant staff member who is in post now, rather than someone who has changed their role.

Commissioned Programme E1 — Environmental Monitoring and Assessment

Programme Officer: Alistair Ferguson
Bristol Environmental Monitoring Manager

Topic Leaders

E1A	Strategy and reporting	Dave Jowett, Head Office, Bristol
E1B	Analytical techniques	Dave Britnell, Thames Region
E1C	Instrumentation and field techniques	Terry Long, National Centre for Environmental Data and Surveillance
E1D	Biological assessment	Paul Logan, Thames Region

Commissioned Programme E2 - Sustainable Development

Programme Officer: Chris Newton, Head Office, Bristol
Head of Sustainable Development

(No Topic Leaders)

Commissioned Programme P1 - Waste Regulation and Management

Programme Officer: Jan Gronow, Steel House, London
Research Manager

Topic Leaders

P1A	Long-term monitoring	Jan Gronow, Steel House, London
P1B	Landfill practices	Jan Gronow, Steel House, London
P1C	Industrial waste management	Paul Tempany, Steel House, London
PID	Options and strategies	Terry Coleman, Steel House, London

Commissioned Programme P2 - Water Quality

Programme Officer: Steve Killeen, Head Office, Bristol
Environmental Standards Manager

Topic Leaders

P2A	Ecotoxicology and Hazardous Substances	Jim Wharfe, National Centre for Ecotoxicity and Hazardous Chemicals
P2B	Consenting and discharge impact	Gerard Morris, North East Region, Phoenix House
P2C	Rural land use	Bob Huggins, South West Region, Blandford
P2D	Groundwater pollution	Bob Harris, National Centre for Ground Water and Contaminated Land
P2E	Pollution prevention	Phil Chatfield, Thames Region

Commissioned Programme P3 - Radioactive Substances

Programme Officer: Clive Williams, Head Office, Bristol
Policy Development Manager

Topic Leaders

P3C	Radiological environment assessment	Stuart Newstead, North West Region, Lancaster

Commissioned Programme P4 - Process Industries Regulation

Programme Officer: Charlie Corbishley, Head Office, Bristol
Process Industries Regulation, Policy Advisor

(No Topic Leaders)

Commissioned Programme P5 - Land Quality

Programme Officer: Valerie Forster, Steel House, London
Land Quality Policy Manager

Topic Leaders

P5A	Information	Malcolm Lythgo, Rio House, Bristol
P5B	Risk assessment	Simon Pollard, Steel House, London
P5C	Analysis	Valerie Forster, Steel House, London
P5D	Remedial treatment	Ian Martin, National Groundwater and Contaminated Land Centre
P5E	Quality assurance	Sue Herbert, Steel House, London

Commissioned Programme W1 - Conservation

Programme Officer: Paul Raven, Head Office, Bristol
Head of Conservation

(No Topic Leaders)

Commissioned Programme W2 - Fisheries

Programme Officer: Dave Clarke, Head Office, Bristol
Head of Fisheries

Topic Leaders

W2A	Salmonid fisheries	Nigel Milner, Welsh Region, National Centre for Fisheries Science
W2B	Coarse fisheries	Phil Hickley, Midlands Region, National Centre for Fisheries Science

Commissioned Programme W3 - Water Recreation and Navigation

Programme Officer: Roger Valentine, Anglian Region
Navigation and Recreation Officer

(No Topic Leaders)

Commissioned Programme W4 - Local Government Liaison

Programme Officer: Veronica Jones, Head Office, Bristol
National Development Planning Manager

(No Topic Leaders)

Commissioned Programme W5 - Flood Defence

Programme Officer: Brian Empson, Head Office, Bristol
Flood Defence Officer

Topic Leaders

W5A	Fluvial	John Fitzsimons, Midlands Region
W5B	Coastal and estuarine	Steve Wheatley, Anglian Region
W5C	Flood warning and forecasting	Peter Borrows, Thames Region

Commissioned Programme W6 - Water Resources

Programme Officer: Aileen Kirmond, Head Office, Bristol
Water Resources Manager

Topic Leaders

W6A	Hydrometric data	Scott Ferguson, Southern Region
W6B	Flow regimes	Mike Owen, Thames Region
W6C	Water resources management	Cameron Thomas, Anglian Region
W6D	Groundwater resources	Steve Fletcher, Midlands Region National Centre for Ground Water and Contaminated Land
W6E	Demand management	David Howarth, National Centre for Water Demand Management

Table A1.3 *R&D Section*

The following lists all those staff in the R&D section, comprising both the R&D unit and the regional R&D management support officers who are in place in the 1998/99 financial year. This has been produced so that if anyone has a query over a specific project they can contact the relevant staff member who is in post now, rather than someone who has changed their role.

R&D Unit, based at Rio House, Bristol	
Mervyn Bramley,	Head of R&D
James Edwards	R&D Programme Officer
Declan Barraclough	R&D Planning Officer
Kim Thomas	R&D Technical Officer
R&D Service, based at Westbury-on-Trym	
Bogus Zaba	R&D Service Manager
Carrie Freeman	Technical Assistant
Management Support Officers	**Region**
Gill Davies	Head Office - Bristol
Dave Bird	Head Office - Bristol
Alan Sweeting	Head Office - London
Richard Smith	Head Office - Bristol
Martin Smalls	Anglian
Peter Braithwaite	Anglian
Mike Briers	North East
Irene Gize	North West
Rikki Womersley	Midlands
Jo Jeffries	Midlands
Sean Finnigan	Southern
Toby Hutcherson	South West
Nicky Bailey	Thames
Maxine Forshaw	Thames
Henry Brown	Welsh

Table A1.4 *R&D Project Managers for the 1997/98 Programme*

ANGLIAN
J Adams, C McArthur, C Ashcroft, B Ayling, A Barnden, A Baxendale, D Beardell, T Brown, P Buckland, D Burgess, S Chadd, R Chattergee, N Cooper, J Coultrup, G Daly, I Forbes, M Grout, P Hart, G Heald, R Hillier, J Hogg, S Lane, N Osborne, M Pearson, G Phillips, J Pitt, M Smalls, D Tester, M Tyler, A Usborne, R Valentine, P Waldron, A Wallis, D Warn, I Welby, S Wheatley.

HEAD OFFICE - BRISTOL
P Bird, M Bramley, S Carlyle, J Chapman, C Chubb, J Dalton, B Empson, M Everard, T Fanshawe, A Ferguson, D Foster, J Fraser, A Holt, R Howell, A Hughes, J Hunt, D Jowett, J Kersey, S Killeen, A Kirmond, G Llewellyn, M Lythgo, C Newton, R Palmer, H Partridge, M Quinn, P Raven, S Silvey, M Sitton, R Streeter, N Sweet, A Taylor, I Taylor, S Thurley, G Walters, G Watts, P Williams.

HEAD OFFICE - LONDON
A Anjun, M Clark,T Coleman, P Dolley, S Duerden, D Edwards, C Foan, V Forster, J Gronow, J Gulson, C Harvey, J Irwin, M Meadows, P Newman, C Powlesland, P Tempany, R Timmis, B Thompson R Yearsley.

MIDLANDS
B Baker, D Brewin, A Broughall, V Brown, P Buckland, N Burke, A Churchward, P Coxhill, A Crawford, P Crockett, P de HÈnaut, J Dolby, S Evers, J Fitzsimmons, S Fletcher, A Hart, A Heaton, P Harding, R Harris, S Howard, P Hufton, T Jacklin, J Jeffries, M LeRay, I Martin, D Pettifer, A Picken, S Powers, A Roe, J Smith, C Tucker, R Wade, R Ward, D Woodcock, R Yates, B Zaba.

NORTH EAST
J Aldrick, R Armitage, M Briers, E Chalk, L Chalk, E Clegg, O Clymer, M Cross, J Ellis, R Freestone, T Hardy, B Hemsley-Flint, V Hirst, A Lewis, H Lowes, K Miller, G Morris, S Pedder, G Pierson, J Pygott, M Scott, J Shelley, K Slaney.

NORTH WEST
V Anspoks, A Aprahamian, A Bell, P Birghall, D Clifton-Dey, G Edwards, G Fitzgerald, P Fox, M Hagger, J Hillary, C Jarvis, D Jordan, P Jones, D McCubbing, A Milner, I Parker, T Pickering, K Rouen, J Shatwell, P Spencer, O Wedgewood, C Weedon, M Weston, P Wiggins, A Wither.

SOUTHERN
M Baker, G Beamish, P Beaverstock, N Berry, A Buckley, G Burrow, M Davies, R Dines, S Fewings, I Grey, N Haylor, A Hopkins, D Howarth, I Johnson, D Lowthian, O Pollard, E Sanz, P Shaw, T Sykes, D Tinsley, M Whiting.

SOUTH WEST
L Aucott, D Bird, S Bray, G Brighty, K Broad, N Caetano, A Davis, C Doidge, M Gorton, R Grew, M Harget, N Holden, R Huggins, L Jenkins, T Long, J McEvoy, T Newman, J Proctor, R Saull, R Saxon, R Smith, N Stevens, S Thomas, A Weston, S Woods, C Wright.

THAMES
N Bailey, P Borrows, N Bray, D Britnall, A Brook, A Brookes, J Bywater, A Chappell, P Chatfield, S Davies, A Driver, D Forrow, M Forshaw, I Fox, P Greaves, A Greenwell, C Haggett, J Haines, S Hennings, H Howes, D Hybert, L Kizwini, J Krokowski, P Logan, N Lyness, N Marshall, B McGlashan, G Merrick, J Murray-Bligh, K Nursey, K Patrick, A Pepper, M Pilcher, P Power, H Richardson, V Robinson, D Rylands, J Soggee, J Steel, J Thomas, J Wharfe, H Wilkinson, A Williamson, D Willis, B Winter, C Woolhouse, W Yeomans, N Zaman.

WELSH
C Beaver, C Bolton, H Brown, I Davidson, D Evans, R Fisher, P Gough, S Halfacree, T Jones, R Merriman, R Milne, N Milner, S Neale, B Ng, A Rees, M Scott, B Vaughan, A Winstone

APPENDIX 2

R&D Outputs 1997/98

The following provides a list of all R&D outputs that have been produced in the 1997/98 financial year, together with details of their availability and price. These outputs were produced under their respective commissioned programmes but are cross-referenced to the following frameworks or themes (F/T):

F1 - Framework 1:	Viewpoints
F2 - Framework 2:	Stresses and strains
F3 - Framework 3:	Risks and values
T1 - Theme 1:	Addressing climate change
T2 - Theme 2:	Regulating major industries
T3 - Theme 3:	Improving air quality
T4 - Theme 4:	Managing waste
T5 - Theme 5:	Managing our water resources
T6 - Theme 6:	Delivering integrated river-basin management
T7 - Theme 7:	Conserving the land
T8 - Theme 8:	Managing our freshwater fisheries
T9 - Theme 9:	Enhancing biodiversity

If you are interested in obtaining the full R&D outputs or only the Technical Summary, then please contact the Environment Agency Dissemination Centre: The Bookshop Manager, Water Research Centre (WRc), Franklin Road, Blagrove, Swindon, Wiltshire SN5 8YF. Tel: 01793 511711, Fax: 01793 514562. Prices are available on request.

E1 - Environmental Monitoring and Assessment

Project No.	Output Reference	Title	F/T	External Availability
E1-001	Project Record E1/001/1	A Review of Automatic Samplers and Waste Water Monitoring Equipment	F2	N
E1-001	Project Record E1/001/2	Instrumentation for Self-Monitoring: A Legal Review	F1	N
E1-001	Technical Report E32	Specification for Automatic Sampling Equipment for the UWWTD	F2	Y
E1-001	Technical Report E33	Strategy for Auditing the Self-Monitoring Programme	F1	Y
E1-008	Project Record E1/008/1	Analysis of 1995 Survey Data and RIVPACS Update – Consultation Process for the Development of the Phase 2 Schedule of Research	F2	Y

Project No.	Output Reference	Title	F/T	External Availability
E1-008	Technical Report E26	RIVPACS III and User Manual including Software	F2	N
E1-523	Technical Report E35	Operating Manual for Moored Marine Monitor	F2	N
E1-533	Technical Report E15	New Sampling and Analytical Methods: Pesticides and Transformation Products in Chalk Aquifers	F2	Y
E1-533	Note 435	Analytical Method for the Determination of Triazine Herbicides and their Transformation Products in Chalk Aquifer Material	F2	Y
E1-533	Note 436	Analytical Method for the Determination of Isoproturon and its Transformation Products in Chalk Aquifer Material	F2	Y
E1-620	Technical Report E9	National Database of Recreational Fresh Water Quality – Scoping Study	F1	Y
E1-626	Technical Report E21	Method Development for Chromium (III) and (VI) in Seawater	F2	Y
E1-672	Technical Report E62	Final Report on the Acid Waters Survey for Wales: Volume 1, Main Text	F1	Y
E1-696	Technical Report E25	Operational Mechanisms for the Protection and Enhancement of Headwaters – Scoping Study	T9	Y
E1-700	Technical Report E22	Measurements of Residual Oxidants	F2	N
E1-700	Project Record E1/i700/1	Measurements of Residual Oxidants	F2	N
E1-711	Technical Report E45	Evaluation of Mini Metal Sensors Phase 2	F2	N

E2 - Sustainable Development

Project No.	Output Reference	Title	F/T	External Availability
E2-005	Technical Report E44	Resource Demand Management Techniques for Sustainable Development	F3	Y
E2-007	Technical Report E46	Green Household Index – The EcoCal	F3	Y
E2-009	Technical Report E36	What Matters and Why – Environmental Capital: A New Approach	F3	Y
E2-708	Technical Report E65 (AEAT-1924)	Management of Harm to the Environment: Final Report	F3	N

Project No.	Output Reference	Title	F/T	External Availability
CPR/238	Project Record E2/238/1	DEMIS Initial Development Project	F3	Y
CPR/238	Project Record E2/238/2	DEMIS Introduction Manual	F3	Y
CPR/238	Project Record E2/238/3	DEMIS Reference Manual	F3	Y

P1 - Waste Regulation and Management

Project No.	Output Reference	Title	F/T	External Availability
P1-203	Technical Report P171 (CWM 035A/94)	The Technical Aspects of Controlled Waste Management: Laboratory Studies of Landfill Leachate-Triassic Sandstone Interactions	T4	Y
P1-211	Technical Report P172 (CWM 151/96)	Perceptions and Communication: Issues for Waste Management	F3	Y
P1-218	Technical Report P174 (CWM 142/96A)	Guidance on the Emissions from Different Types of Landfill Gas Flares	T4	Y
P1-218	Project Record PP035	Guidance on the Emissions from Different Types of Landfill Gas Flares	T4	Y
P1-228	Technical Report P173 (CWM 121/95)	Development of PCR Techniques and DNA Probes for Detection, Enumeration and Identification of Methanogens in Landfills	T4	Y
P1-228	Project Record PP020	Development of PCR Techniques and DNA Probes for Detection, Enumeration and Identification of Methanogens in Landfills	T4	Y
P1-235	Technical Report P177 (CWM 158/96)	Field Trials of Compost for Agriculture	T4	Y

P2 - Water Quality

Project No.	Output Reference	Title	F/T	External Availability
P2-001	Technical Report P78	Sustainable Systems of Outdoor Pig Production	T6	Y
P2-017	Technical Report P84 (MTF Report 29)	Report of the UK Mirror Task Force: Environment – Water	F2	Y
P2-020	Technical Report P112	Review of Colour Monitoring Techniques	F2	Y
P2-021	Technical Report P96	Detailed Audit Protocol for Laboratories that Self Monitor under UWWTD	T3	Y
P2-022	Technical Report P111	Remote Surveillance of Mineral Extraction Discharges	F2	Y

Project No.	Output Reference	Title	F/T	External Availability
P2-027	Technical Report P53	Aquatic Litter Information System Using Digital Technologies	F1	Y
P2-030	Technical Report P72	Benthic Algal Mats in River Systems	T6	Y
P2-047	Technical Report P113	Alternative Farming Methods (Arable – Phase 2)	T6	Y
P2-049	Technical Report P136 (FR/CL 0007)	National Consent Translation Project (NCTP) Phase II	T5	Y
P2-050	Technical Report P73	Corporate Environmental Reporting in the UK Water Sector – A Concise Review	F1	Y
P2-051	Note 393	The Implementation of the Urban Wastewater Treatment and Nitrates Directive	T6	N
P2-051	Note 440	The Current Monitoring Strategies in Selected Member States	F1	N
P2-051	Note 477	Self-Monitoring of Effluent Discharges – Current Strategies Used in Selected Member States and the USA	F1	N
P2-063	Project Record P2/063/1	PRAIRIE™ Protocol	F3	Y
P2-275	Technical Report P104	Colour Standards for Watercourses	T6	Y
P2-275	Project Record P2/i275	Colour Standards for Watercourses	T6	Y
P2-390	Technical Report P14	Biogeochemical Controls on Phosphorus Cycling Between Sediment and Water in Estuaries	T6	Y
P2-436	Project Record P2/i436/1	Removal of Colour from Industrial Dyehouse Effluent Using Biosorption	T6	Y
P2-493	Technical Report P28	Toxicity Reduction Evaluation Case Summary for the Pulp and Paper Industry	T2	Y
P2-493	Project Record P2/i493/11	Toxicity Reduction Evaluation Case Summary for the Pulp and Paper Industry	T2	Y
P2-537	Technical Report P175 (CIRIA Report 167)	Use of Industrial By-Products in Road Construction – Water Quality Effects	T6	Y
P2-553	Technical Report P206	Farm Effluent Treatment: An Innovative Approach	T6	N
P2-623	Technical Report P2	Groundwater Pollution Research Reviews	T5	Y
P2-623	Technical Report P3	Bioremediation Technology Research	T6	Y
P2-623	Technical Report P4	Products Enhancing Biodegradation of Hydrocarbons	T6	Y

Project No.	Output Reference	Title	F/T	External Availability
P2-649	Technical Report P176	Building a Cleaner Future – Construction Site Pollution Prevention	T5	Y
P2-662	Technical Report P32	Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources	F2	Y
P2-662	Technical Report P33	Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources – Literature Review	F2	Y
P2-662	Project Record P2/i662/03	Identification and Quantification of Groundwater Nitrate Pollution from Non-Agricultural Sources – Literature Review	F2	Y
P2-686	Technical Report P19	Review of the Use of Chlorine for Sewage Disinfection	T6	Y
P2-707	Technical Report P68	PRAIRIE™ Guidance	F3	Y
P2-707	Technical Report P69	Development of PRAIRIE™ Dispersion Modelling	F3	Y
P2-707	Technical Report P70	Updating of PRAIRIE™ Databases	F3	Y
P2-720	Technical Report P47	Evaluation of Blue-Green Algal Blooms	T6	N

P3 - Radioactive Substances

Project No.	Output Reference	Title	F/T	External Availability
CPR/4	Technical Report P50	The Removal of Technetium from EARP Waste Streams, Phase II	T4	Y
CPR/182	Technical Report P97	The Nuclear Agency Database of Features Events and Processes – Application by the Environment Agency	T2	N
CPR/191	Technical Report P95	Maintenance of HMIP/Environment Agency Assessment Toolkit	T2	Y
CPR/201	Technical Report P55	The Removal of Technetium from EARP Waste Streams, Phase III	T4	Y
CPR/208	Technical Report P93	3D Colloid Migration in a Non-Uniform Slot Fracture	T4	Y

P4 - Process Industries Regulation

Project No.	Output Reference	Title	F/T	External Availability
P4-028	Technical Report P105	Control of Mercury and Cadmium in Liquid Discharges	T2	Y

Project No.	Output Reference	Title	F/T	External Availability
P4-028	Project Record P4/028/1	Control of Mercury and Cadmium in Liquid Discharges	T2	Y
P4-060	Technical Summary PS187	Evaluation of BATNEEC/BPEO Cases in Applications for Authorisation of the Electricity Supply Industry	T2	N
CPR/119	Technical Report P62	Exposure Commitment Approach to the Derivation of Environmental Assessment Levels: Feasibility Study	T2	Y
CPR/131	Technical Report P92	An Assessment of the Feasibility of Using DGT Procedures to Measure Trace Metals and Radionuclides in Rivers	T2	Y
CPR/139	ISBN 0-11-702010-9	Released Substances and their Dispersion in the Environment: Guidance for Applicants for Process Authorisation under Integrated Pollution Control	T2	Y
CPR/239	Technical Report P56	Environmental Protection Act 1990 – Best Practicable Environmental Option and Other Assessment Methods: Case Study Comparisons	T2	Y
CPR/256	Technical Report P61	Dioxin Markers Feasibility Study	T2	Y

P5 - Land Quality

Project No.	Output Reference	Title	F/T	External Availability
P5-029	Technical Report P107	Literature Assessment of Ecotoxicity Testing for the Evaluation of Contaminated Land	T7	N

W1 - Conservation

Project No.	Output Reference	Title	F/T	External Availability
W1-003	Project Record W1/003/1	Nutrient Management in Rivers	T6	Y
W1-013	Project Record W1/013/1	The Agency's Role in River SSSIs, SPAs and SACs	T9	N
W1-019	Project Record W1/019/1	Investigation and Monitoring of Anthropogenic Diseases in Wild Animals	T9	N
W1-517	Technical Report W86	River Morphology and Plant Relationships	T9	Y
W1-531	Technical Report W54	Catchment Ecosystem Research and Development – Scoping Study	T9	Y

Project No.	Output Reference	Title	F/T	External Availability
W1-552	Publication 2 (CIRIA Report 180)	Review of the Design and Management of Constructed Wetlands	T6	Y
W1-633	Technical Report W108	Deeside Rivers Survey: Final Report	T9	Y

W2 - Fisheries

Project No.	Output Reference	Title	F/T	External Availability
W2-001	Technical Report W95	River Fisheries Habitat Inventory (Phase 1) - Scoping Study	T8	N
W2-007	Technical Report W33	Genetic Stock Discrimination of Atlantic Salmon at Catchment or Sub-Catchment Levels	T8	Y
W2-007	Technical Report W90	Genetic Stock Identification (GSI) in Atlantic Salmon: Phase 1	T8	Y
W2-009	Technical Report W93	Development of Lightweight Backpack Electric Fishing Gear	T8	N
W2-013	Technical Report W60	Review of Sea Trout Fecundity	T8	Y
W2-019	Project Record W2/19/1	Database and Atlas of Freshwater Fishes in the UK: Pilot Project 1996/97	T8	Y
W2-023	Technical Report W75	Factors Affecting Coarse Fish Recruitment	T8	Y
W2-025	Technical Report W96	Evaluation of the Close Season in Canals	T8	Y
W2-152	Report 30	The Impact of Land Use on Salmonids: A Study of the River Torridge Catchment	T8	Y
W2-152	Technical Report W67	Changes in Agricultural Land Use in the Torridge Catchment 1952 to 1988	T8	N
W2-152	Technical Report W68	Studies of Historical Water Quality in the Torridge Catchment and Comparisons of Current Water Qquality in Intensively and Non-Intensively Farmed Sub Catchments	T8	N
W2-152	Technical Report W69	In Situ Salmon Embryo Experiments, Sedimentological Survey and Juvenile Salmon Bioassay Experiments in the Torridge Catchment	T8	N
W2-152	Technical Report W70	Studies of Adult Salmonid Catches and Juvenile Salmonid Populations in the Torridge Catchment	T8	N
W2-312	TechnicalReport W81	The Movements of Atlantic Salmon (Salmo salar L.) and Sea Trout (Salmo trutta L.) Smolts in the Impounded Estuary of the River Tawe, South Wales	T8	Y

Project No.	Output Reference	Title	F/T	External Availability
W2-370	Technical Report W23	Design and Use of Open Channel Resistivity Fish Counters - Advisory Manual	T8	N
W2-388	Note 386	The Regulation of Fish Farming by the National Rivers Authority	T8	Y
W2-452	Technical Report W5	The Effects of Stocked Brown Trout on the Survival of Wild Fish Populations	T8	N
W2-452	Technical Report W74	A Review of Consented Trout Stockings into Riverine Environments	T8	Y
W2-486	Technical Report W92	The Use of a Hydroacoustic counter for Assessing Salmon Stocks	T8	Y
W2-551	Technical Report W64	Spawning Escapement Targets for Atlantic Salmon	T8	Y
W2-551	Technical Report W65	The Transportation of the Maximum Gain Salmon Spawning Target from the River Bush (N.I.) to England and Wales	T8	Y
W2-573	Technical Report W66	Smolt Trapping Using Acoustic Techniques, Phase 1	T8	Y
W2-584	Technical Report W44	Restoration of Riverine Salmon Habitats: A Guidance Manual	T8	Y
W2-596	Technical Report W101	An Assessment of Cormorant Depredation on Stillwater Coarse Fish Populations in the Lea and Colne Valleys of the Thames Catchment	T8	Y
W2-675	Technical Report W91	Development of a Life Cycle Simulation Model for Atlantic Salmon – Scoping Study	T8	Y
W2-691	Technical Report W58	The Status of Headwater Stream Fish Populations and their Tolerance to Low-Level Habitat Degradation	T8	Y

W3 - Recreation and Navigation

Project No.	Output Reference	Title	F/T	External Availability
W3-002	Technical Report W76	Private Boating Price-Demand Relationship	T6	N
W3-002	Project Record W3/002/1	Private Boating Price-Demand Relationship	T6	N
W3-692	Project Record W3/i692/1	The Safe Use of Instream Structures - Response to Questionnaire Survey	T6	N

W4 - Local Government Liaison

Project No.	Output Reference	Title	F/T	External Availability
W4-641	Technical Report W77	Review of Natural Resource Plans and Development Programmes	F3	Y
W4-641	Project Record W4/i641/1	Review of Natural Resource Plans and Development Programmes	F3	Y
W4-680	Technical Report W32	A Methodology for Community Involvement in LEAPs	F3	Y
W4-680	Project Record W4/i680/6	A Methodology for Community Involvement in LEAPs	F3	Y

W5 - Flood Defence

Project No.	Output Reference	Title	F/T	External Availability
W5-001	Technical Report W53	Economic Benefits of Flood Warning and Forecasting	T6	N
W5-013	Technical Report W13	Review of Lone Worker Beacon	F3	N
W5-027	Technical Report W109	Fluvial Design Guide	T6	Y
W5-033	Technical Report W85	Water Level Management Plans – Scoping Study	T6	Y
W5-508	Technical Report W88	Benchmarking and Scoping Study of Hydraulic River Models – Stage Two: Final Report	T6	Y
W5-516	Report 31 (CIRIA Report 157)	Guidance on the Disposal of Dredged Material to Land	T6	Y
W5-518	Publications (JNCC Series)	Coasts and Seas of the United Kingdom – Coastal Directories, Volumes 1-17	F1	Y
W5-566	Technical Report W12	Historic Changes in Saltmarshes	T7	Y
W5-589	Technical Report W16 (CIRIA Ref: FR/CP/40)	Hydraulic Design of Culverts	T6	Y
W5-685	Technical Report W38	Guidance on Development in Areas at Risk from Tidal Flooding	T6	Y
W5-724	Technical Report W41	Earth Embankment Fissuring Manual	T6	Y
W5-724	Project Record W5/172/3	Earth Embankment Fissuring Manual	T6	Y
W5-730	Technical Report W47	Strategic Remote Sensing of Coastal Types: Feasibility Study Part 1: Executive Summary and Outline Report	F2	Y
W5-730	Technical Report W56	Strategic Remote Sensing of Coastal Types: Feasibility Study Part 2: Main Report and Appendices	F2	Y
W5-734	Technical Report W105	Biological Control of Weeds – A Scoping Study of the Feasibility of Biological Control of Aquatic and Riparian Weeds in the UK	T6	Y

W6 - Water Resources

Project No.	Output Reference	Title	F/T	External Availability
W6-015	Technical Report W72	Appraisal of the Use of Ecological Information in the Management of Low Flows in Rivers	T5	N
W6-015	Project Record W6/015/1	Appraisal of the Use of Ecological Information in the Management of Low Flows in Rivers	T5	N
W6-027	Technical Report W116	Evaluating the Impact of Restrictions on Customer Demand: Main Report	T5	Y
W6-282	Technical Report W48	Ecologically Acceptable Flows, Phase II: Determination of Ecologically Acceptable Flows in Rivers with Seasonal Changes in the Density of Macrophytes	T5	Y
W6-455	Technical Report W28	The Hydrogeological Classification of Superficial Clay: Hydrogeological Characterisation of Glacial Till in East Anglia	T5	Y
W6-455	Technical Report W29	The Hydrogeological Classification of Superficial Clay: Hydrogeological Characterisation of Glacial Till and Glacio-Lacustrine Sediments in Shropshire	T5	Y
W6-455	Technical Report W30	The Hydrogeological Behaviour of the Clay-with-Flints of Southern England	T5	Y
W6-455	Technical Report W31	The Hydrogeological Classification of Superficial Clay: Methodology of Map Production	T5	Y
W6-455	Project Records 455/01 /NW, 455/02A/NW to 455/02F/NW, 455/03A /NW to 455/03C/NW, 455/04/NW	The Hydrogeological Classification of Superficial Clays	T5	Y
W6-544	Technical Report W9	Groundwater Resource Reliable Yield – User Manual	T5	Y
W6-544	Project Record W6/i544/7	Groundwater Resource Reliable Yield – User Manual	T5	Y
W6-544	Technical Report W10	Key Components in Methodology Formulation	T5	Y
W6-628	Publication No. 5	Broadleaf Woodlands: The Implications for Water Quantity and Quality	T5	Y
W6-659	Technical Report W84	Abstraction Metering – Good Practice Manual	T5	Y
W6-705	Technical Report W71	The Evaluation of Acoustic Doppler Current Profiler Equipment	T5	Y
W6-705	Project Record W6/i705/1	The Evaluation of Acoustic Doppler Current Profiler Equipment	T5	Y

APPENDIX 3

Ongoing Projects in 1997/98

The following provides a list of all projects (with project number and project title) ongoing from the 1997/98 R&D programme (as at 31 March 1998) which were not completed in that financial year. It is divided up into the 13 R&D commissioned programmes.

E1 - Environmental Monitoring and Assessment

Project No.	Title
E1-003	Ecotoxicological method development - Stage 2
E1-004	Improved environmental monitoring - Phase 2
E1-005	Estuarine water quality model: Phase 3 - Further training
E1-006	Data transmission requirements for self-monitoring equipment
E1-007	Development of improved methodologies for analysis of biological data (RIVPACS)
E1-011	Development of freshwater blue-green algal flora
E1-014	Sensors for ammonia detection
E1-015	Manual for biological methods - Phase 1
E1-016	Development of analytical methods for pesticides
E1-019	Synoptic state of the environment monitoring
E1-020	Coastal monitoring for medium-term trend analysis – Phase 1
E1-022	Sensors for nutrients - Phase 2
E1-023	Development of a strategy for cost-effective targeting of aircraft remote sensing using satellite images
E1-024	Expert system for lake macrophytes
E1-026	Evaluation of reduced solvent techniques for organics analysis
E1-027	Comparison of extraction techniques for solid matrices
E1-028	Transportable accurate pH meter for monitoring saline waters
E1-029	Mechanisms coastal transport of contaminants to Cardigan Bay
E1-030	Phosphatase activity in rivers
E1-033	Review of endocrine effects on invertebrates - Phase 1
E1-034	Monitoring of biota in marine water for endocrine disruption
E1-036	Analysis of the 1995 biological survey - Phase 2
E1-037	Development of soil data storage and analysis with land information system (LANDIS)

Project No.	Title
E1-038	Freshwater input to Countryside Survey 2000 (CS2000)
E1-040	Application of remote sensing to protected area and urbanisation topographical changes
E1-041	Use of remote sensing to provide accurate information for modelling climate change
E1-042	Analytical methods for cationic polyacrylamides
E1-044	Application of remote sensing for assessing the status and conditions of land
E1-047	Integrating environmental development strategies – long-term monitoring
E1-048	Approaches to assessing aesthetic quality of the environment
E1-050	Application of neural networks to analytical techniques
E1-051	International conference - Integrated Environmental Assessment
E1-052	Methods for assessing ecological health of the environment
E1-053	Response of European freshwater lakes to environmental and climatic changes
E1-621	Artificial intelligence in river quality surveys
E1-642	Biological techniques of still water quality assessment - Phase 2
E1-667	Further development and testing of an ammonia instrument
E1-694	Assessment of trophic status of rivers using macrophytes
E1-704	Microbiological techniques - Phase 3
E1-712	Alternative methods of biological classification of rivers
E1-721	Lakes: monitoring and classification - Phase 2
E1-726	European pollution control philosophy - Phase 4
E1-732	New ways of sharing Agency science with schools
E1-733	Non-sewage derived faecal indicators - bathing beaches
E1-S01	Use of macrophytes for environmental monitoring of rivers
E1-T02	Technical service - Freshwater Biological Association (FBA)
E1-T03	Analytical quality control and method development - technical service
E1-T04	Sampling and statistics technical service

E2 - Sustainable Development

Project No.	Title
E2-001	Strategic risk assessment
E2-002	Public perception and customer research
E2-003	Green accounting - evaluation of environmental damage
E2-004	ExternE - the externalities of energy
E2-010	Climate change impacts
E2-011	Environmental risk assessment case studies for HARM
E2-012	Towards sustainable European water management - Water 21
E2-014	Cost recovery charging effectiveness
E2-016	Integrated model to predict European land use (IMPEL)
E2-017	Environmental impact of an EC structural fund programme
E2-018	The environmental impacts of developments - Guidance for surveyors
E2-022	Environmental capital Phase 2: Piloting the methodology
E2-S01	Studentship - Transferability of environmental benefits - a methodological test in relation to bathing waters
E2-S02	Studentship - Economic valuation of wetlands
E2-S03	Studentship - Transferability of environmental benefits - air quality
E2-S04	Studentship - Perception and evaluation of environmental risk
CPR/2	Assessment of environmental risk standards in the UK

P1 - Waste Regulation and Management

Project No.	Title
P1-016	Instrumentation of a permeable liner in the base of Stangate East landfill site
P1-173	Managing the provision of information for the national land
P1-198	Artificial enhancement of biological methane oxidation
P1-199	The preparation of technical guidance for the spreading of industrial waste on land
P1-201	A review of the UK household waste arisings
P1-209	Acceleration of waste stabilisation at Walpole landfill site, Somerset
P1-210	Field trials of waste manipulation techniques - Phase 1

Project No.	Title
P1-214	Assessment of the risks to human health of materials recovery facilities - a framework for decision makers
P1-217	Nitrogen balances in landfill
P1-219	Measurement of gas potential for landfilled materials
P1-221	Leachate monitoring for the Brogborough test cells
P1-226	Study of the emissions from different types of landfill gas
P1-227	Investigation of the effectiveness of clinical waste treatment procedures
P1-229	Long-term fate of metals in landfills
P1-232	Development of a national waste production survey
P1-237	Industrial and commercial waste database - Phase 1
P1-238	Feasibility of national waste exchange
P1-239	Life cycle inventory (LCI), data quality guidelines - Phase 2
P1-250	Technical support for landfill research management
P1-254	Development of methods for obtaining values for cation exchange capacities
P1-255	Red list substances in landfill leachate - Phase 2 - further development of analytical methods
P1-256	LANDSIM model - Phase 2
P1-257	National household waste analysis programme - Phase 3
P1-259	Flushing bioreactor field trials at the Brogborough test cells - Phase 1
P1-260	An assessment of the behaviour of organic waste composting
P1-261	Composting programme - Phase 3 - production of a composting guidance document
P1-265	National waste GIS programme - Phase 3.2 - collection of data for landfills in Berkshire
P1-266	National waste GIS programme - Phase 3.2 - data collection for the development of a national GIS system - London and Surrey
P1-269	Life cycle inventory (LCI), development of the environmental burdens resulting from the transport of household and similar wastes
P1-270	Life cycle inventory (LCI), development of the environmental burdens resulting from the collection and separation of household and similar wastes
P1-271	Methane emissions from different landfill categories - Phase 2

Project No.	Title
P1-272	Life cycle inventory (LCI), development of the variable environmental burdens resulting from the incineration of household and similar wastes
P1-273	Life cycle inventory (LCI), development of the fixed environmental burdens resulting from the incineration of household and similar wastes
P1-274	Life cycle inventory (LCI), development of the environmental burdens resulting from the landfilling of household and similar wastes
P1-275	Further development of nucleic acid probes for monitoring microbial activity in landfill sites
P1-276	Life cycle inventory (LCI), composting and anaerobic digestion
P1-277	Life cycle inventory (LCI), development of the environmental burdens resulting from the recycling of household and similar wastes
P1-278	Life cycle inventory (LCI) impact assessment - Phase 6.1
P1-279	Waste classification scheme - Phase 6 - classification software
P1-283	Framework to assess the risks to human health and the environment from landfill gas - Phase 1
P1-284	Assessment of criteria for landfill completion
P1-287	Disposal of End-of-life vehicles
P1-288	Assessment of the risks to human health of waste transfer stations - a framework for decision makers
P1-291	Industrial and commercial waste database - Phase 2
P1-292	Solid phase acceptability test for landfill co-disposal
P1-293	Development of a general approach to leaching tests
P1-294	Risk assessment - Phase 3 - development of risk assessment methodology for landfill sites - LandSim
P1-296	Life cycle programme - Phase 6.2 - waste management impact assessment methodologies
P1-297	Waste classification scheme - Phase 4
P1-298	National waste GIS programme - Phase 3.1- contract management of data collection
P1-301	Leachate injection and recirculation field trials
P1-303	Environmental impact of old landfills - Phase 2 - long-term monitoring
P1-306	Nitrogen balances in landfills - Phase 2.2 - ammonia fluxes
P1-309	Life cycle programme - Phase 7.2 - decision analysis tool part 1
P1-311	Composting programme - Phase 2.5 - a review of European and American composting practices

Project No.	Title
P1-315	Assessment of the risks to human health from composting of household wastes - a framework for decision makers
P1-316	Field trials of waste manipulation - Phase 3 - waste pretreatment
P1-317	Application of tracer studies for monitoring leachate recirculation in landfill
P1-319	The use of composted refuse to accelerate methanogenesis - a review
P1-326	Refuse collection vehicle emissions modelling
P1-329	Home composting assessment methodology and life cycle impact inventory development
P1-331	Development and use of waste sampling methods - Phase 1 - regulatory, classification and assessment procedures
P1-344	Waste pretreatment prior to landfilling - Phase 1- scoping study
P1-347	Landfill monitoring - preparation of waste management paper 26D
P1-352	Monitoring accelerated waste stabilisation at Brogborough
P1-355	Life cycle programme - Phase 7.3 - comparison of scenarios using proprietory life cycle assessment tools
P1-386	National waste GIS programme - Phase 3.3 - collection of landfill data from Beds, Herts, and Bucks

P2 - Water Quality

Project No.	Title
P2-003	Herbicide losses from hard surfaces
P2-005	Integrated wastewater technology validation
P2-006	Integration of upper tiers and intermittent standards - Phase 3
P2-007	Dangerous substances in sewerage networks
P2-008	Impact of pesticides on river ecology - Phase 2
P2-009	Alternatives to DWF in setting discharge consents
P2-011	Mine closure planning
P2-013	Farm waste disposal through brokerage
P2-014	Land management techniques - Phase 3 (buffers zones)
P2-015	Application of DTA techniques for monitoring groundwater
P2-016	Aesthetic impact of oil spills on shorelines

Project No.	Title
P2-019	Environmental impact of treated wastes and by-products in road construction
P2-024	Pollution potential of cemeteries
P2-026	Forestry operations: Best practice guidance
P2-028	Biological remediation of acid mine waters
P2-029	Causes of poor water quality in headwater streams
P2-031	Isotropic fractionation as a diagnostic tool for in situ biodegradation
P2-034	Expert system for consenting discharges - Phase 2 technical support
P2-036	Application of pesticide run-off models to larger catchments
P2-038	Long-term monitoring of highways surface water run-off
P2-048	UPM workbench and review of manual implementation
P2-051	Breakdown of oil-related products in oil separators
P2-053	Review and appraisal of water pollution control equipment
P2-055	Selection of small sewage treatment systems
P2-057	Microbiology of Wheal Jane
P2-058	Greater use of recycled materials in construction
P2-059	Site guide - environmental good practice for site operations
P2-060	Fate and behaviour of detergents - Phase 2
P2-061	Fate and impact of contaminants in estuaries and coastal waters
P2-062	Integration of the management of health and safety, quality and environment
P2-064	Review of sludge treatment and disposal techniques
P2-065	UK sewage sludge survey 1997/98
P2-066	Innovative cost-effective methods of farm waste treatment
P2-067	Impact of conifer harvesting and replanting on upland water quality
P2-068	BenOss model - development of user interface
P2-069	Pilot catchment study of nutrient sources - control options
P2-072	Oestrogenic steroids in the aquatic environment
P2-073	Review of UPM manual
P2-074	Farm pollution risks best practice manual - Phase 2

Project No.	Title
P2-075	Integrated and sustainable mixed farming (The Marches - BEAM)
P2-076	Using Asulox for bracken control - Phase 1 - scoping study
P2-077	Appraisal of the impact of multiple retailers' QA schemes
P2-079	Investigation of atmospheric deposition of nitrogen
P2-080	Review of LNAPL monitoring techniques in groundwater
P2-081	Environmental impact of controlled burns
P2-082	Development of a methodology for the derivation of sediment standards
P2-083	Environmental monitoring of anti-fouling biocides
P2-085	Determining the causes of apparent eutrophication effects
P2-087	Integration of clean-up guidance on soils and groundwater
P2-088	Processing and presentation of groundwater quality data
P2-089	Review of impact of microbiological contaminants in groundwater
P2-090	Acid waters monitoring - indicator populations
P2-092	National compilation of time and travel data
P2-093	Chemical techniques manual
P2-095	Operational and policy guidance on use of hydrogen peroxide
P2-097	Application of risk assessment techniques to discharge control - scoping study
P2-099	R&D product training for water quality projects
P2-101	Feasibility study for in situ bioremediation of nitrate
P2-102	Disposal of oiled beach materials (OBMs) in sandy coastal environments
P2-103	OECD fellowship - sediment pollution impact on salmon and trout
P2-104	Review of flow monitoring techniques for STWs
P2-105	Public attitudes to oil pollution
P2-108	Bathing water policy - Phase 1 (scoping study)
P2-109	Review of proprietary prefabricated oil storage tank systems
P2-110	Best practicable environmental option for first-time rural sewerage
P2-112	Use of in situ bioassays and biomarkers to assess contamination
P2-113	Identification of sites for the reception of waste following major oil spills
P2-115	Development of environmental quality standards - Phase 5

Project No.	Title
P2-116	Development of sheep dip strategy
P2-117	Industrial by-products in road construction - Phase 2
P2-118	Environmental problems from anti-fouling agents
P2-123	Soil erosion control in maize
P2-124	Novel and environmentally benign methods of nitrate removal
P2-125	Dense non-aqueous phase liquid (DNAPL) pollution in Permo-Triassic sandstone aquifers
P2-127	Assessment of nutrient removal impacts on eutrophic rivers
P2-128	Development and piloting of an integrated best management practices (BMP) manual
P2-131	Guidance on the auditing of sewer modelling procedures
P2-132	Coastal protection procedures for major oil spills
P2-434	Pathogens from farming practices - Stage 3
P2-462	Zinc from watercress farms
P2-561	Cryptosporidium in farmed and wild animals.
P2-575	Alternative farming methods - dairy
P2-598	Remediation of groundwater pollution by organic solvents
P2-607	The use of genetically modified organisms as pollution tracers
P2-639	Sources and impacts of nutrients in estuaries - Phase 2
P2-645	Geomembranes in aggressive leachate environments
P2-648	Fate and behaviour of detergents in wastewaters and rivers
P2-655	Quantifying point source inputs of pesticides - Phase 2
P2-688	Development of EQSs - Phase 4
P2-690	Efficacy and effects of wastewater disinfection - Phase 5
P2-703	Toxicity based criteria for assessing receiving water quality - Phase 2
P2-713	Effects of old landfill sites on groundwater quality - Phase 2
P2-725	Oestrogenic substances in STW effluents - Phase 2: industrial effluents
P2-7207	Application of LANDSIM to contaminated land
P2-7231	Control of pollution from separately sewered areas
P2-7240	Modelling leachate migration in Triassic sandstones

Project No.	Title
P2-7242	High-resolution electrical monitoring of groundwater
P2-7244	Biodegradation of organic pollutants in the unsaturated zone
P2-7277	Natural attenuation of organic pollutants in groundwater
P2-S01	Real-time water quality modelling, forecasting, information and control systems
P2-S07	Potential use of willows and poplars as components of practical buffer zones (Studentship)
P2-S10	Characterisation of seepage and spoil erosion from abandoned mined land
P2-S15	Evaluating the effectiveness of pollution prevention awareness campaigns
P2-S16	Constructed wetlands for the treatment of urban run-off
P2-T01	Specialist enquiry service
P2-T02	Technical service – Blue-green algal toxicity assessment and toxin analysis
P2-T03	Wastewater treatment and UPM technical service
P2-T04	Ecotoxicology technical service (NCET)

P3 - Radioactive Substances

Project No.	Title
P3-010	Scientific review and assessment of Nirex submissions
P3-011	Development of geostatistical methods of evaluating the effects of different amounts of data
P3-012	G4: Geoscience database
P3-013	Jordan natural analogue study - Phase 3.
P3-014	Chemistry of blended cements and backfills for use in radioactive waste disposal
P3-015	Continuation of dynamic flow studies of simulated groundwater
P3-016	Support and maintenance of CAIRS system
P3-017	Thorium migration study - S Africa
P3-019	AIMS database and library support
P3-020	Technical review (programme area review)
P3-022	Integrated colloids programme - CARESS
P3-023	Decovalex - development of chemical/transport models

Project No.	Title
P3-024	Gas generation and migration in radioactive waste disposal systems
P3-026	Proposal assessment system for radioactive waste disposal sites
P3-027	Fault hydrogeology and the performance of radioactive waste repositories
P3-028	Study of the migration of actinide-bearing colloids at the field scale - Steenkampskraal
P3-029	Effects of organic substances in groundwater on the migration of radionuclides
P3-030	Environmental and food chain impacts of the disposal of solid radioactive waste
P3-031	Palaeohydrogeological modelling for potential future repository sites
P3-032	Criticality in post-closure safety assessment of radioactive waste repositories
P3-033	Interpretation of optimisation in the context of a disposal facility for long-lived radioactive waste
P3-034	Research on cementitious materials - international context
P3-036	Investigation of the sources and fate of radioactive discharges to public sewers
P3-037	Expert judgement and risk assessment
P3-039	Review of the environmental impact of radioactive discharges on non-human species
P3-045	Status report on gas migration and two-phase flow through engineered and geological barriers
P3-046	Continuation of development of the thermodynamic database
P3-047	Cement review
P3-048	Implementation of the NEA FEP database by the Agency
P3-049	Technical support for the Agency's input to international radioactive waste disposal studies
P3-M01	Research management support for P3

P4 - Process Industries Regulation

Project No.	Title
P4-010	Atmospheric dispersion modelling system - Research and technical support
P4-011	Atmospheric dispersion modelling system - further development

Project No.	Title
P4-012	Development and validation of a pollutant dispersion model
P4-014	Provision of water quality information and hazard scores
P4-015	Dioxin congener profiles - changes between environmental compartments
P4-016	Collation of data for the priority substances information system
P4-017	Provision of pollution climate information and support
P4-018	Assessment of the environmental effects of power stations
P4-019	Assessment of the environmental effects of acid rain deposition
P4-020	Development of critical load methodologies for toxic metals in soils and surface waters
P4-021	Chairman of toolkit framework group
P4-023	Demonstration project for waste minimisation - Dee
P4-025	Demonstration project for waste minimisation - Medway
P4-026	Gas cloud imaging project
P4-029	Development of APPRAISE assessment tool - Phase 2
P4-030	Environmental toolkit - planning and mobilisation - Phase 2
P4-031	Development and validation of biomonitoring decision support system
P4-034	Technical secretariat to the EAC - bridging contract
P4-035	Strategic review of the petroleum refinery industry sector
P4-036	Scoping study for the use of electronic noses
P4-037	Statistical investigation - Phase 1: Uncertainty and incompatibility in the use of data
P4-038	Development of the Environment Agency Substances Information System (EASIS)
P4-040	Regulated processes and exceedances of air quality standards - scoping study
P4-043	Provision of pollution climate information - air - Phase 2
P4-044	Substitute liquid fuels (SLF) used in cement kilns - life cycle analysis
P4-045	Development of BPEO assessment methodology for waste disposal from IPC processes
P4-049	Control of dangerous substances - hydrocarbons and IPC
P4-051	Computational fluid dynamics modelling of atmospheric dispersion

Project No.	Title
P4-053	Strategic review of coal quality on power station emission
P4-056	Provision of economic information on inorganic chemical processes
P4-057	Provision of economic information on organic chemical processes
P4-061	Performance of low NOx burners for high-temperature furnaces
P4-062	Research work into reducing NOx from moving grate municipal incinerators
P4-063	Research works into improvement to the plasma treatment of incinerator off-gas
P4-064	Demonstration of the feasibility of SOILPACS
P4-066	Substitute liquid fuels (SLF) used in cement and lime kilns - international perspective
P4-071	Preparation of emulsion PVC BAT note
P4-072	Pulp and paper processes - BPEO study
P4-073	Clinical waste disposal risk assessment
P4-F01	Development of a regional multi-media partition for organic compounds
P4-S01	Spatial and temporal trends of power station-derived pollutants
P4-M01	Technical project management support for P4 (BPEO related)

P5 - Land Quality

Project No.	Title
P5-001	Laboratory analysis of soil from contaminated land
P5-003	Evaluation and selection of measures for contaminated land
P5-005	Risk assessment and development of guideline values for contamination in soil - Phase 4
P5-007	Development of procedural and technical guidance for land contamination regulation
P5-008	Model procedures on risk management - Phase 2
P5-011	Development of technical guidance for special sites
P5-012	Concerted Action on Risk Assessment for Contaminated Sites (CARACAS)
P5-013	Collation of toxicological data for soil contaminants - Phase 5
P5-014	Demonstration of remedial action technologies for land contamination (NATO/CCMS pilot study)

Project No.	Title
P5-016	Research management support to contaminated land programme
P5-017	Risk communication and perception for contaminated land
P5-020	Research council liaison - Phase 2
P5-021	EPSRC WPM co-ordination - Phase 1
P5-022	UK database on remediation of contaminated land - Phase 1

W1 - Conservation

Project No.	Title
W1-002	Rehabilitation of degraded habitats - Phase 2
W1-008	Hierarchical catchment models based upon geomorphology etc
W1-011	Invertebrates of exposed riverine sediments (ERS) - Phase 2
W1-012	Effectiveness of water fringe option scheme on water quality
W1-015	Otter biodiversity action plan
W1-016	Impact of discarded fishing line and tackle on wildlife
W1-017	PLANTPACS - Phase 1
W1-018	River habitat survey (RHS) - underwater video of flow-related features
W1-019	Dead otters: post mortem and tissue analysis - Phase 2
W1-020	River management for special areas of conservation - EU LIFE
W1-021	Species management Phase 3 - Southern Damselfly conservation
W1-022	Native black poplars - Phase 2
W1-023	Characterisation of rivers
W1-025	Population dynamics of the otter recovery in southern region
W1-026	River habitat survey - habitat inventory and applications
W1-028	River habitat survey - educational package
W1-029	River management guidelines
W1-030	Scoping study for the eradication of alien crayfish populations
W1-031	Waterways breeding bird survey (WBBS)
W1-032	Implications of future shoreline management on habitats
W1-539	River channel typology for catchment and river management
W1-601	Functional analysis of European wetland systems

Project No.	Title
W1-611	River habitat survey - Phase 2
W1-640	Species management in aquatic habitats
W1-654	Dead otters – post-mortem and tissue analysis
W1-663	Coarse woody debris of British headwater rivers
W1-665	Fish-eating birds of Great Britain
W1-671	Shad conservation in England and Wales
W1-682	Species management - water vole and mink interactions

W2 - Fisheries

Project No.	Title
W2-003	Habscore - conversion of software to stand-alone system
W2-004	Optimum level of rod licence enforcement - Phase 1
W2-005	Coarse fish migration - occurrences, causes and implications
W2-010	Chalkstream salmon stock decline - Phase 1
W2-011	Fish population changes in biomanipulated sites
W2-014	Effects of endocrine disrupting substances on fish - Phase 2
W2-015	A scoping study to establish the issues on coarse fisheries
W2-016	Semi-quantitative electrical fishing for classification
W2-017	Year class strengths and recruitment in a grayling population
W2-020	Coarse fish literature review
W2-021	Salmon radio tracking in South West England
W2-022	Fluid exchange and oxygen flux through salmonid redds
W2-024	Smolt trapping using acoustic techniques - Phase 2
W2-026	Swimming speeds in fish
W2-028	Eel and elver stocks in England and Wales - status and management options
W2-029	Identification key for the juvenile stages of coarse fish
W2-030	Effects of water quality on coarse fish movement and production
W2-032	Database and atlas of freshwater fishes - Phase 2
W2-034	Transporting salmon spawning targets

Project No.	Title
W2-035	Development of lightweight backpack electrofishing gear - Phase 2
W2-036	Investigation into spring carp mortality syndrome
W2-037	Validation techniques for hydroacoustic assessment
W2-038	Development of salmon life cycle simulation model - Phase 2
W2-404	The use of catch statistics to determine fish stock size
W2-582	Effects of electric fishing on fish and fishing
W2-613	North East coast fishery study
W2-636	Assessment of oestrogenic effects in wild fish - phase 1
W2-651	Optimum stocking strategies for coarse fish
W2-674	Sea trout investigations - Phase 3
W2-719	Development of systems for designing fisheries surveys
W2-F01	Fellowship: Population dynamics of underyearlings

W3 - Recreation and Navigation

Project No.	Title
W3-001	Impact of recreation on wildlife
W3-010	Supply and demand study - the needs of the disabled
W3-011	Determination of cost benefit of recreational facilities
W3-012	Sustainable recreational use of flood banks
W3-723	Hydroelectric power for navigation services

W4 - Local Government Liaison

Project No.	Title
W4-002	The inclusion of economic appraisal to local environment action plans (LEAPs)
W4-003	Implementation and planning gain - opportunities for partnerships
W4-004	Environmental assessment of external projects - Phase 4
W4-006	Carrying capacities of catchments - scoping studies

W5 - Flood Defence

Project No.	Title
W5-001	Design and operation of trash screens - Phase 3
W5-002	Sediment tracer studies - Phase 1 (Medway Estuary)
W5-003	Sustainable urban run-off - Phase 2
W5A003	Management of vegetation on raised embankments
W5B003	Definition of the extent and vertical range of saltmarsh
W5-004	Coastal defence design and practice guide
W5-005	Comparison of different forecasting models
W5B005	Construction risk in coastal engineering - designers' manual
W5-006	Overtopping of seawalls
W5C006	Improving the accuracy of rainfall radar data - Phase 2
W5-007	Guidelines for coastal monitoring database - Phase 2
W5C007	Wave and wind data and real-time models - feasibility study
W5-008	Risks management techniques for reservoir safety
W5A008	Rainfall frequency studies - Phase 2
W5-010	Predicting extreme water levels in estuaries for flood warning
W5-011	River bank protection stabilisation - willows
W5-012	Marine sand and gravel resources - developments in NW Europe
W5-013	Shingle beach transport models
W5-015	Saltmarsh sediment tracer studies - Phase 2 (Orwell Estuary)
W5-016	Restoration of vegetation on saltmarshes
W5-017	Coastal study of 3-D sand transport and morphodynamics
W5-023	Examination of underwater structures
W5-027	Fluvial design manual - Phase 2
W5-032	Civil engineering applications of geophysical investigations
W5-034	Design guide for site drainage
W5-036	Satellite alarm field evaluation (SAFE)
W5-039	Disposal of cut vegetation
W5-042	Freeboard: Standard practice manual
W5-043	Integrated catchment models (EUROTAS)

Project No.	Title
W5-044	Rainfall frequency studies - Phase 3
W5-279	Use of timber in sea defence schemes
W5-459	Risk assessment for sea and tidal defence structures
W5-510	Thunderstorm warning system
W5-546	Evaluation of integrated flood warning systems
W5-588	Dredging techniques and operations
W5-591	Saltmarsh sedimentation processes
W5-592	Pollution of managed retreat sites
W5-599	Estuary morphology and processes
W5-600	River bank protection, Phase 2 - site trials/demonstration
W5-609	Sediment research in flood channel - Phase 5
W5-627	Snow melt modelling - Phase 2
W5-635	Guidance manual for bank protection techniques
W5-661	Geomorphological approaches for river management
W5-677	Barrages
W5-679	Quality assurance for survey techniques
W5-697	Managed retreat: A guide to consents and licences
W5-698	Global positioning system network for monitoring of ground subsidence
W5-731	Long-term morphological modelling of intertidal mudflats (INTRMUD)
W5-8004	Benefits of urban maintenance operations
W5-8010	River basin modelling, management and flood mitigation (RIBAMOD)
W5-8019	Aquatic weed control operation - Phase 3
W5-9446	River maintenance evaluation - Phase 3
W5-A01	Expert support for national R&D flood defence: fluvial
W5-A02	Expert support for national R&D flood defence: coastal
W5-A03	EPSRC programme coordinators - CEWE programme
W5-A04	Expert support for national R&D flood defence: flood warning
W5-M01	Contracted R&D management support officer for Anglian Region
W5-S01	Resuspension of fine sediment by estuarine waves

Project No.	Title
W5-S05	Appraisal of geomorphological and hydraulic impacts on Flood Defence
W5-S06	Geomorphological assessment of river restoration schemes
W5-T02	Centre for Aquatic Plant Management (CAPM)

W6 - Water Resources

Project No.	Title
W6-001	Flows over "flat v" weirs under non-modular conditions
W6-003	Assessment of the potential for aquifer storage recovery in England and Wales
W6-005	Methodology for benefit of hydrometric networks
W6-007	Manual of minor aquifer properties
W6-008	Low head flow measurement techniques
W6-009	Drought orders/permits - best practice monitoring guidelines
W6-010	The use of mathematical models for determining residual flow requirements of estuaries
W6-011	The effectiveness of converting WCs to dual-flush
W6-012	Forecasting demand components
W6-014	Operation and protection of adit systems in UK aquifers
W6-016	Overseas approaches to river flow objectives
W6-017	Groundwater recharge assessment - Phase 2 scoping study
W6-018	Water-saving in industries dependent on direct abstraction
W6-019	Methodology for interpreting GW quality data
W6-020	A fractured/fissured rock approach to groundwater protection zone mapping
W6-021	Modelling flow sequences at the ungauged site
W6-023	Effect of climate change on river flows and groundwater recharge
W6-027	Evaluating the impact of demand management
W6-029	Fish pass effects on hydrometric data from gauge structures
W6-030	Framework to assess environmental costs and benefits for a range of water management options
W6-031	A socially acceptable and environmentally effective strategy for household water metering

Project No.	Title
W6-032	Vulnerability mapping for the protection of carbonate (Karstic) aquifers
W6-033	Environmentally friendly systems and products
W6-034	Strategic review of groundwater modelling
W6-035	Effective methods of communicating water conservation and demand management
W6-045	UK Groundwater Forum Secretariat
W6-587	Groundwater tracer studies - best practice manual
W6-608	Autonomous technologies and building services
W6-614	Improved modelling of flow of water in abandoned mines
W6-638	Enhanced low-flow estimation at the ungauged site
W6-646	Calibration of gauging stations using portable ultrasonics
W6-687	Water-saving technology in buildings
W6-722	Baseline quality of aquifers
W6-8104	Fracturing and the hydrogeology of permotriassic sandstones
W6-8106	Review of flow needs for fish and fisheries
W6-A01	Periodic review - short reports
W6-T01	R&D technical services for the water resource function

APPENDIX 4

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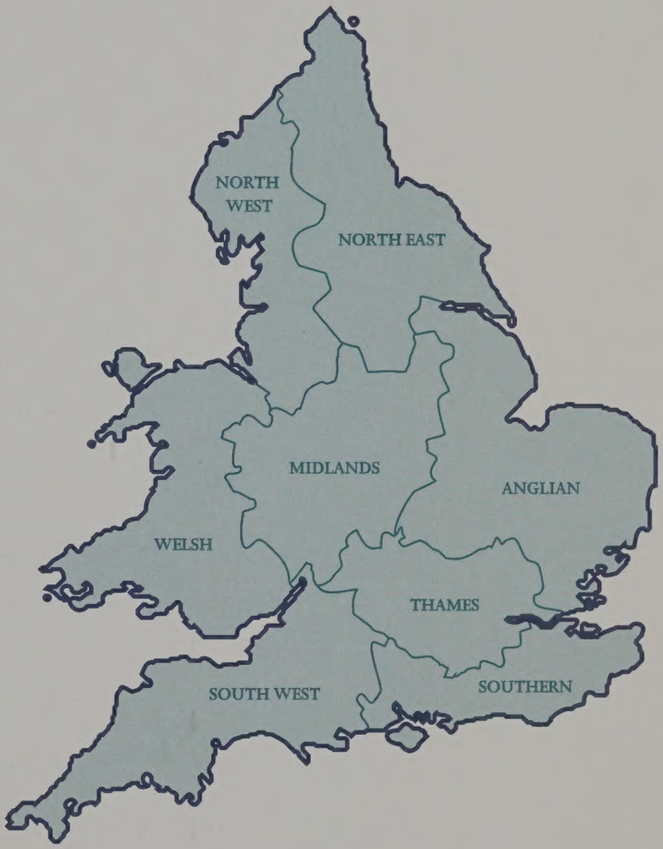

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